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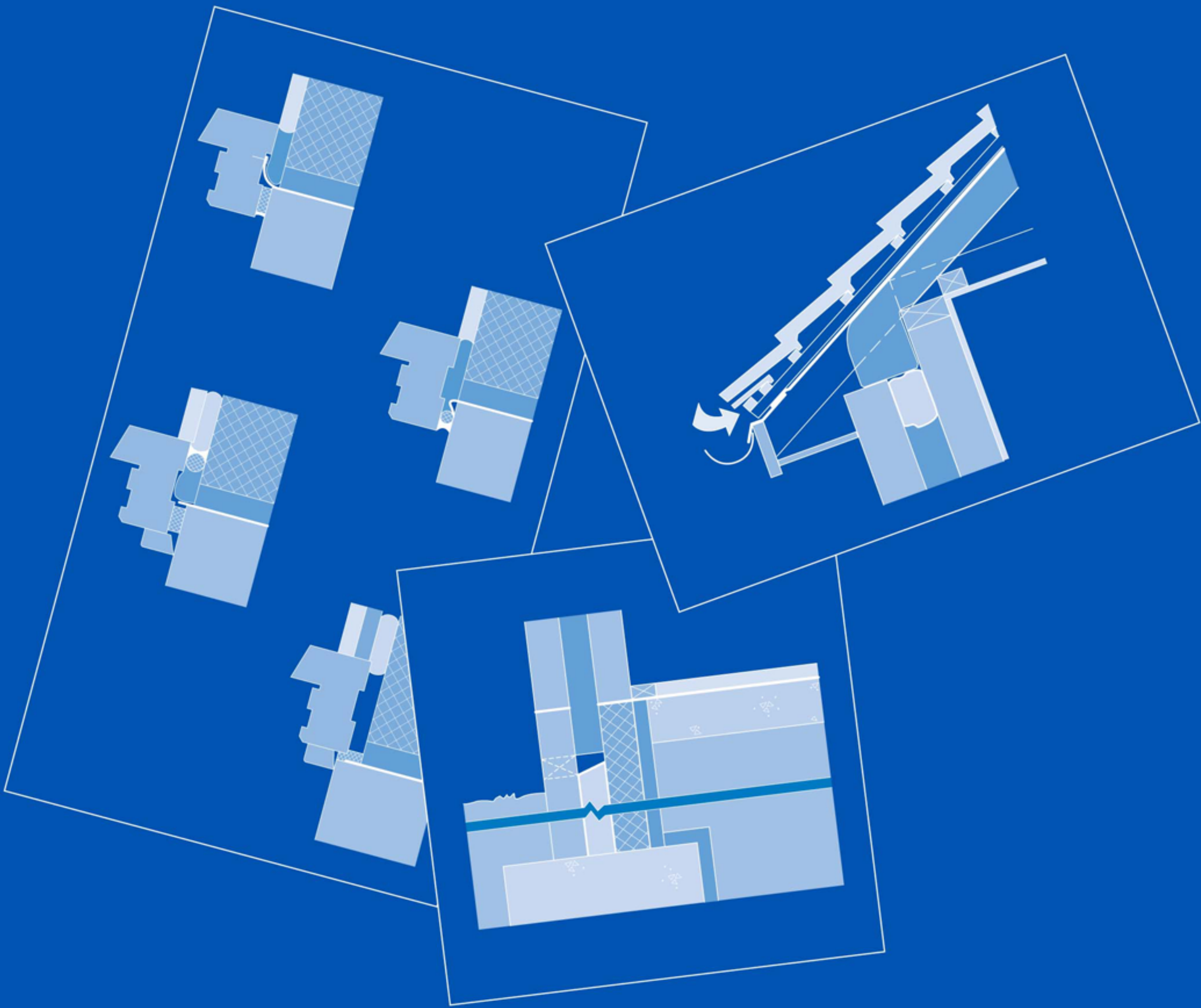
Thermal insulation: avoiding risks



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The guidance in this report draws upon the research and experience of BRE. It has been subject to external review and amended where appropriate to reflect a concensus of views. BRE invites feedback from readers on the enclosed guidance, particularly where new or novel applications are envisaged. Please address your comments and suggestions to:

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Thermal insulation: avoiding risks

A good practice guide supporting building regulations requirements

2002 edition
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Introduction

Scope

This report represents an update of the BRE guide first produced in 1989 and extensively revised in 1994. The approach of these earlier editions, highlighting the link between risks, causes and solutions, has been retained. This updated edition contains a number of revisions resulting from developments in research, changes in materials, construction techniques and the building regulations. The guide has been prepared to support the building regulations for the conservation of fuel and power. The information in this guide represents the recommendations of BRE on good design and construction practice associated with thermal standards; it is not a document approved to satisfy all requirements of the building regulations. Users of the publication are responsible for the correct application of the advice provided.

The guide discusses the more important technical risks associated with meeting the requirements of building regulations for thermal insulation. Technical risks are highlighted and these are followed by actions that could be taken to avoid the risk. In assessing risks for a particular building, consideration should be given to the environmental conditions likely to occur both inside and outside the building, and its expected life.

Format

The guide is divided into five sections relating to the major elements of the building. These sections are broken down into sub-sections to reflect alternative construction methods and the impact of the position of insulation within the construction. Each section concludes with a list of quality control checks for use on site.

Illustrations outline generic construction principles and good practice details. These examples are not exhaustive and designers and builders may have established other details that are equally suitable.

R Given the high proportion of existing buildings which do not meet current thermal standards, those sections which are relevant to buildings subject to renovation, conversion or alteration are marked by a green box, see left.

Definitions

Thermal bridge

Part of the structure of lower thermal resistance that bridges adjacent parts of higher thermal resistance and which can result in localised cold surfaces on which condensation, mould growth and/or pattern staining can occur.

Vapour permeable membrane

A thin membrane with a vapour resistance not more than 0.25 MNs/g used for restricting liquid water penetration whilst allowing water vapour transfer, eg as a tiling underlay or covering to sheathing.

Vapour control layer

A term which replaces both vapour check and vapour barrier. A material, usually a membrane, that substantially reduces the water vapour transfer through any building component in which it is incorporated. Throughout the guidance examples of materials or membranes are given which could be considered as vapour control layers, eg 500 gauge (0.12 mm) polyethylene. These recommendations are based on the material's ability to restrict water vapour. However, in some circumstances in may be prudent to specify a more robust technical solution where conditions on site could result in damage (eg tears or rips) to membranes or materials.

Contents

1

Whole building

Holistic approach to sustainable energy conservation

Scope of this section

This section deals with the building and its use as a whole rather than with the performance of individual elements such as roofs, walls, etc.

Heating, ventilation, solar gain, building use, construction technology and form need to be considered in conjunction with thermal insulation to obtain the required internal conditions and optimum energy efficiency.

R This guidance is of particular relevance when a building is being renovated or converted.

Principal technical risks

1.1 Inadequate design
1.2 Inappropriate construction techniques
1.3 Inadequate protection from external environment
1.4 Disregard for through-life performance

Risks and avoiding actions

1.1 Inadequate design

Thermal insulation, heating and ventilation should be considered as part of a total design, which takes into account all heat gains and losses. Failure to do so can lead to inadequate internal conditions, eg condensation and mould, and the inefficient use of energy due to overheating or the use of artificial cooling.

Domestic and non-domestic buildings

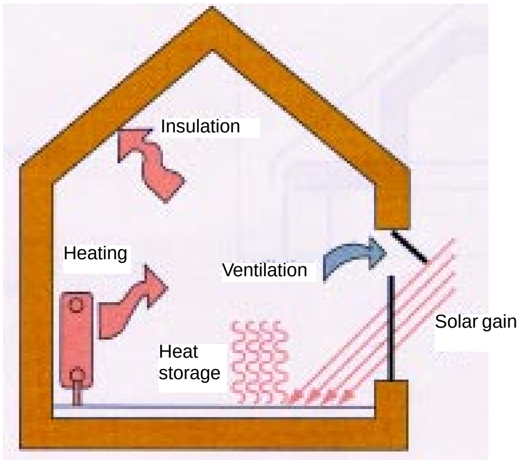
1.1(a) Consider thermal insulation, heating and ventilation together since they interact in providing satisfactory internal conditions (Figure 1).

1.1(b) Insulate the structure uniformly, avoiding thermal bridging (Figure 1). Position the insulating layer so as to provide a design appropriate to the heating system, eg:

- internal insulation and timber frame construction are compatible with rapid response heating systems, such as warm air heating systems,
- external insulation or cavity fill is suited to hot water central heating systems that provide background heat, and for buildings that can exploit solar gains.

1.1(c) Provide a well controlled heating system. Install heat emitters in rooms where heat will not be gained from heated spaces elsewhere in the dwelling.

1.1(d) Prevent the distribution of moisture laden air throughout the dwelling, particularly to unheated spaces, by passive or mechanical extract ventilation close to the source.



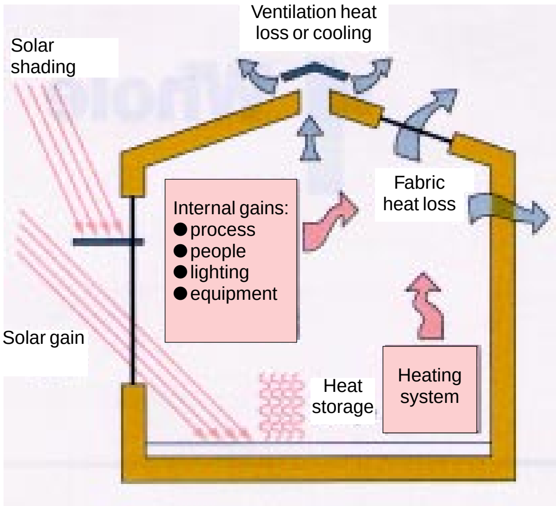
See 1.1(a), (b)

Figure 1 Insulation, heating and ventilation interact in providing satisfactory internal conditions

1.1(e) Assess risks attached to construction and thermal insulation measures against environmental conditions arising out of the proposed use and life expectancy of the building.

1.1(f) Design to achieve satisfactory internal conditions with the least use of energy by balancing heat losses (fabric and ventilation) and heat gains (from solar radiation, processes, people, lighting and equipment) (Figure 2).

1.1(g) Choose an orientation and a system of glazing which maximises solar gain in winter and limits heat gain in summer (Figure 2).



See 1.1(f), (g)

Figure 2 Heat gains and losses balanced to achieve satisfactory internal conditions

1.1(h) Use thermal capacity to limit the effect of heat gains on internal temperatures when the building is occupied.

1.1(i) Use low energy lighting to limit internal heat gains.

1.1(j) Use controls for heating and lighting to provide satisfactory environmental conditions only when and where necessary.

1.1(k) When natural ventilation is not possible, choose a mechanical ventilation system that can take care of occasional overheating without the need for artificial cooling.

1.1(l) Provide extract ventilation from processes that produce water vapour.

1.2 Inappropriate construction techniques

Increased levels of thermal insulation may lead to the inappropriate adaptation of traditional construction technology, eg multi-layer loft insulation leading to ineffective ventilation or thermal bridge at eaves.

1.2(a) Minimise the risk of failure due to changes in construction techniques or process by adopting the use of prefabricated or pre-assembled components where appropriate.

1.2(b) Provide training and specialist supervision where new or novel construction techniques are to be employed.

1.3 Inadequate protection from external environment

Current guidance is provided within this document on estimating the exposure of elements to wind-driven rain. However, concerns have been expressed on the influence of climate change, in particular the increased incidence of high winds and heavy rainfall.

1.3(a) Consider increasing the level of weatherproofing to exposed walls and roofs. In particular to those buildings located at the edges of urban developments or in exposed locations, eg on hillsides, or where full cavity insulation has been installed.

1.3(b) Consider increasing the number of fixings in wall and roof cladding in those areas which are assessed as highly or severely exposed.

1.3(c) In low-lying river or coastal areas, where there is a risk of flooding, choose an insulation system which will be unaffected by flood water. This is particularly important at ground level, thresholds and around openings.

1.4 Disregard for through-life performance

The choice of insulation and heating system is often dictated by initial cost. Failure to take account of the through-life costs of energy efficiency measures will lead to financial and energy losses over the life of the building.

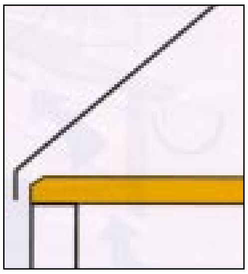
1.4(a) Consider the whole life performance and impact of the choice of energy efficiency measures. Where issues relating to sustainability and environment can contribute to the process these should be included.

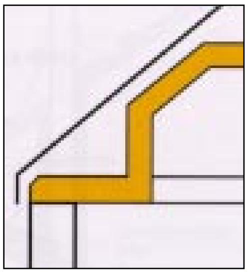
1.4(b) Consider introducing additional energy efficiency measures during the life of the building as opportunities arise, eg replacement of components or elements at refurbishment or remodelling.

2

Roofs

Pitched roofs with ventilated roof spaces





Characteristics of the construction

The insulation is laid at ceiling level for conventional lofts and, in addition, at rafter level for room-in-the-roof designs, creating cold roof spaces or cavities through which ventilation is normally recommended.

In most instances, it is more thermally efficient to lay the insulation as a series of layers — the first between, and subsequent layers across, any areas of thermal bridging, eg ceiling joists and rafters behind inclined ceilings.

R The insulation method is used in renovation work:
- when adding insulation to an accessible loft,
- when converting a loft to a living space,
- when a pitched roof is added above an existing flat roof.

Associated technical risks

2.1 Condensation within roof spaces
2.2 Condensation on the inside of extract ducts passing through unheated roof spaces
2.3 Condensation at thermal bridges
2.4 Risks associated with electrics
2.5 Freezing of water in pipes and cisterns
2.6 Increased heat loss where insulation is not full depth

Risks and avoiding actions

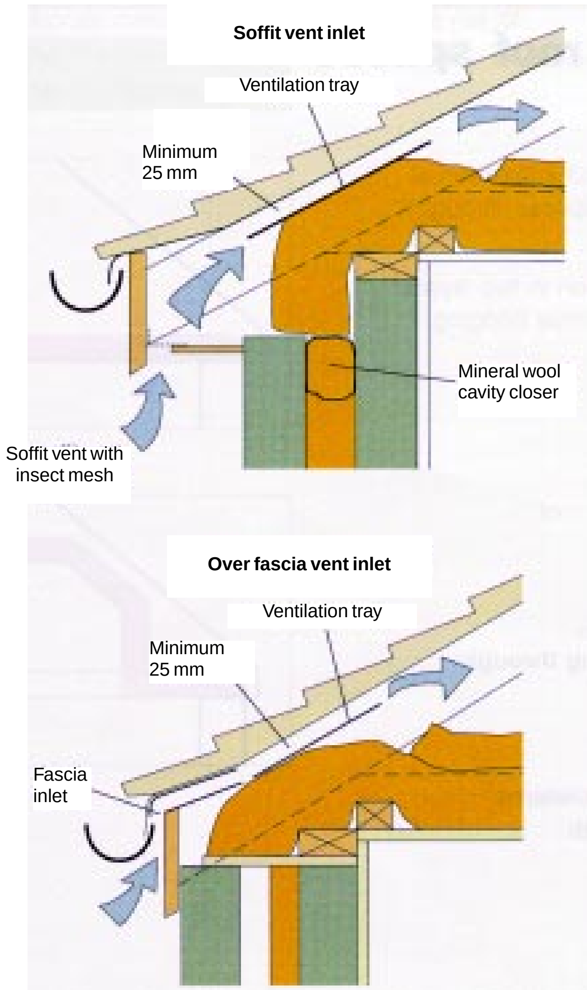
2.1 Condensation within roof spaces

Low winter temperatures will occur in roof spaces which are on the cold side of ceiling insulation. If moist air passes through the ceiling, condensation may form on cold surfaces in the roof structure.

2.1(a) Ventilate the roof space to the outside air via openings at the eaves fascia or soffit with a ventilation area equivalent to a 25 mm continuous gap when the pitch is below 15°, or a 10 mm gap when the pitch is 15° and above (Figure 3).

2.1(b) Place a 3–4 mm mesh across ventilation openings or use a proprietary unit to prevent the entry of insects but ensure that the ventilation area requirements are still met (Figure 3).

2.1(c) Provide a clear air path to the roof space from the eaves ventilation opening equivalent to a 25 mm continuous gap, irrespective of roof pitch (Figure 3).

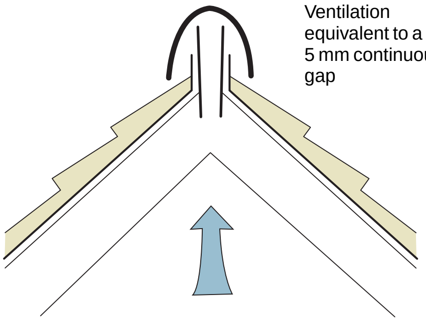


See 2.1(a), (b), (c), (k), (o)

Figure 3 Ventilation to a cold pitched roof at the eaves

2.1(d) Provide additional ventilation openings equivalent to a continuous 5 mm gap at the ridge to cross-ventilate roofs (Figure 4):

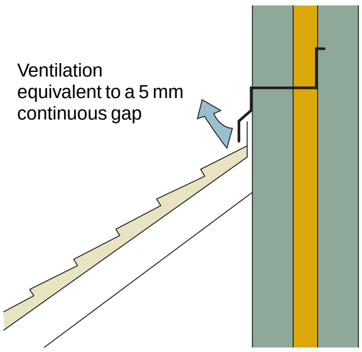
- when the span is more than 10 metres,
- when the pitch is more than 35°.



See 2.1(d), (k)

Figure 4 Additional ventilation to wide or steep roofs

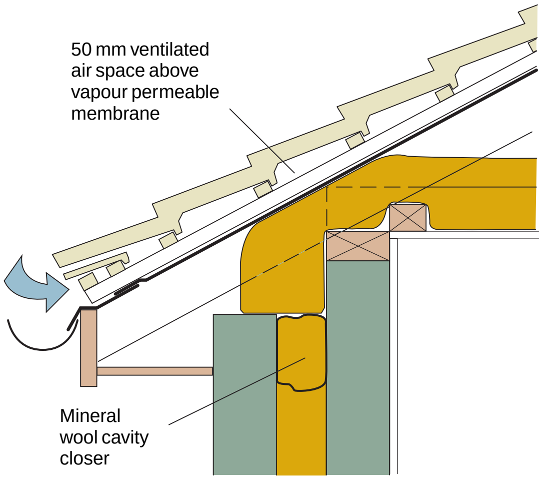
2.1(e) Provide ventilation openings equivalent to a 5 mm continuous gap at high level to roof spaces which are not cross-ventilated eaves to eaves, eg mono-pitched roofs (Figure 5).



See 2.1(e)

Figure 5 High level ventilation for mono-pitched roofs

2.1(f) Alternatively, incorporate a vapour permeable sarking membrane and provide a 50 mm space above the membrane ventilated to the outside (Figure 6). The enclosed roof space does not require additional ventilation as water vapour will diffuse through the permeable sarking underlay. Manufacturers' literature and guidance backed by third-party certification should be adhered to.



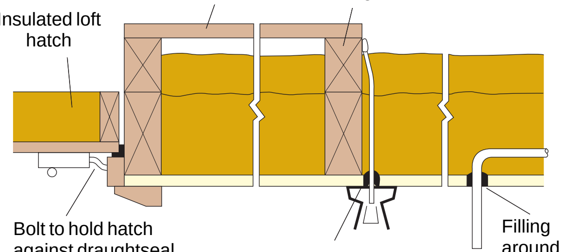
See 2.1(f)

Figure 6 Cold pitched roof incorporating a vapour permeable membrane

2.1(g) Locate flue outlets more than 850 mm below perimeter vents or plastics gutters.

2.1(h) Fill and seal gaps in the ceiling at electrical fittings and where pipes rise from high humidity areas, eg bathrooms and wet areas (Figure 7). Allow for thermal movement associated with stack vents. Where practicable, consider terminating stack vents below the ceiling with an air admittance valve to avoid a hole in the ceiling.

2.1(i) Provide an effective draughtseal to the loft hatch and bolts or catches to ensure it is compressed when hatch is closed (Figure 7).



See 2.1(h), (i), 2.6(a)

Figure 7 Sealing the loft hatch and service penetrations

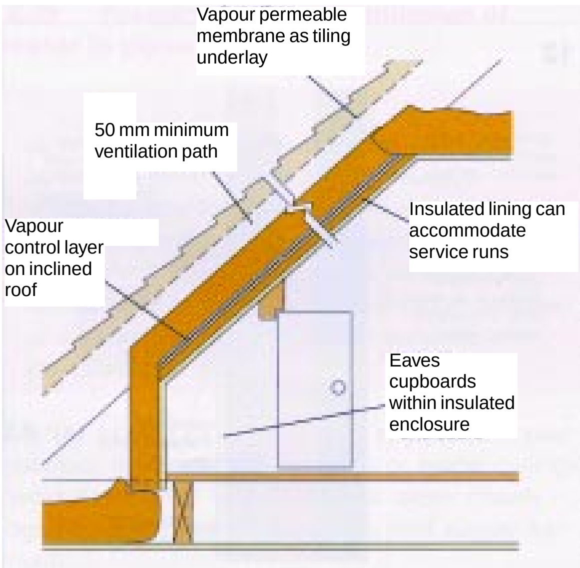
Room-in-the-roof

2.1(j) With high vapour resistance underlays, eg bitumen felts, provide ventilation by means of an air path at least 50 mm deep between the insulation and the tiling underlay (Figure 8). Board insulation is preferable to quilt. Pay particular attention to ventilation paths where the roofline is interrupted by dormers, roof lights, etc.

2.1(k) Ventilate this air path to the outside air with openings in the eaves fascia or soffit equivalent to a 25 mm continuous gap and additional openings at the ridge equivalent to a 5 mm continuous gap (Figures 3 and 4).

2.1(l) Provide a vapour control layer, eg 500 gauge (0.12 mm) polyethylene to inclined ceilings of rooms-in-the-roof and parts of the roof where the ventilation path is restricted, eg where there are complicated roof shapes. Lap and seal joints. The insulated wall to the lower triangle should not be punctured. Storage cupboards should be built within the insulated enclosure (Figure 8).

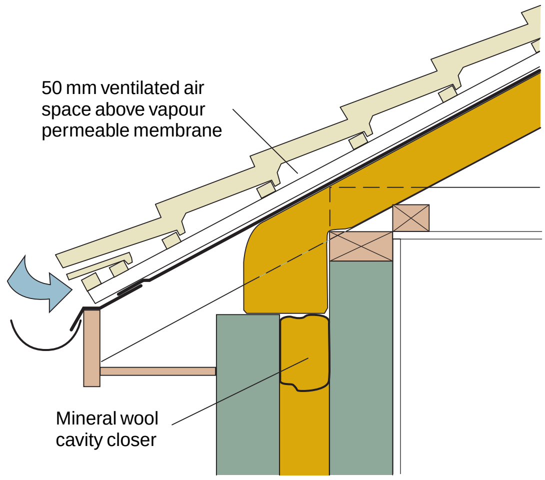
2.1(m) Avoid puncturing the vapour control layer, eg for services. Batten out to create a services zone, or route services within a continuous layer of insulation on the warm side of the vapour control layer (Figure 8).



See 2.1(j), (l), (m)

Figure 8 Room-in-the-roof with eaves cupboards

2.1(n) Alternatively, provide a vapour permeable underlay and provide a ventilated air space between the underlay and the underside of the weatherproof layer, ie tiling (Figure 9). Ventilate this air space to the outside with openings in the eaves fascia or soffit equivalent to a 25 mm continuous gap and additional openings at the ridge equivalent to a 5 mm continuous gap. Consider providing a vapour control layer, eg 500 gauge (0.12 mm) polyethylene to inclined ceilings of rooms-in-the-roof enclosing kitchens, bathrooms and showers.



See 2.1(n)

Figure 9 Room-in-the-roof incorporating a vapour permeable membrane

R

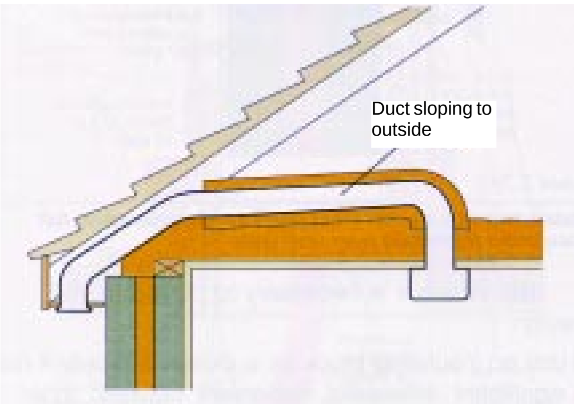
2.1(o) Follow the advice above when retrofitting insulation to an existing roof. When necessary, use over fascia ventilators and ventilating tiles to achieve the required roof space ventilation (Figure 3).

2.2 Condensation on the inside of extract ducts passing through unheated roof spaces

The warm moist air extracted from kitchens and bathrooms cools when it passes through ducts in unheated roof spaces. If the air is cooled below its dew point, moisture will condense on the duct wall and may drip back into the fan unit.

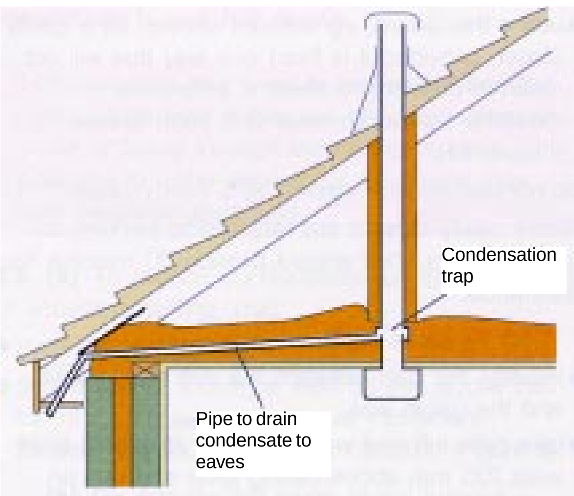
2.2(a) Ensure that all ventilation duct joints are sealed and insulate those ducts that pass through unheated roof spaces using a material that gives a thermal resistance of at least 0.6 m^2 K/W (Figures 10 and 11).

2.2(b) Arrange for the safe dispersal of any condensate which forms within the duct. If the extract discharge is at the eaves, ensure that the duct is laid to a fall. If the extract duct is vertical, provide a condensation trap and a small diameter pipe to drain the condensate to the eaves (Figures 10 and 11).



See 2.2(a), (b)

Figure 10 Insulating a horizontal extract duct



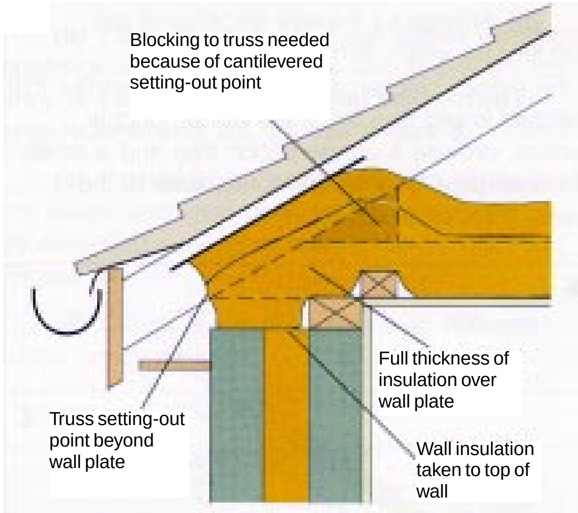
See 2.2(a), (b)

Figure 11 Insulating a vertical extract duct

2.3 Condensation at thermal bridges

Where gaps occur in the insulation, a thermal bridge is created and there is a risk of condensation. A thermal bridge can occur at the junction of a roof or a ceiling with a wall.

2.3(a) Carry the loft insulation over the wall plate to link with the wall insulation (Figure 12). Extending the roof truss setting out point beyond the wall plate avoids compressing insulation between the wall plate and the ventilation tray.



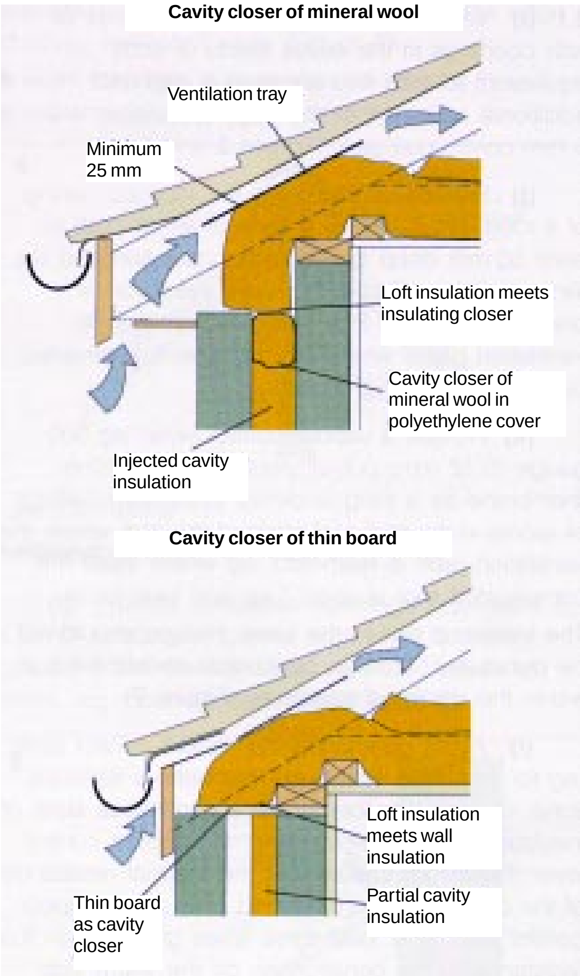
See 2.3(a)

Figure 12 Extending truss setting out point to accommodate full insulation thickness over wall plate

2.3(b) Where it is necessary to close the wall cavity:

- use mineral wool in a polyethylene cover as a cavity closer to avoid any damage from differential movement between, for example, block inner and brick outer leaves, *or*
- use a thin board, eg calcium silicate, as a cavity closer, provided it is fixed in a way that will not result in problems if there is differential movement between inner and outer leaves (Figure 13).

Do not use dense masonry as a cavity closer. Where cavity closers are required to perform as cavity barriers, they should provide 30 minutes fire resistance.



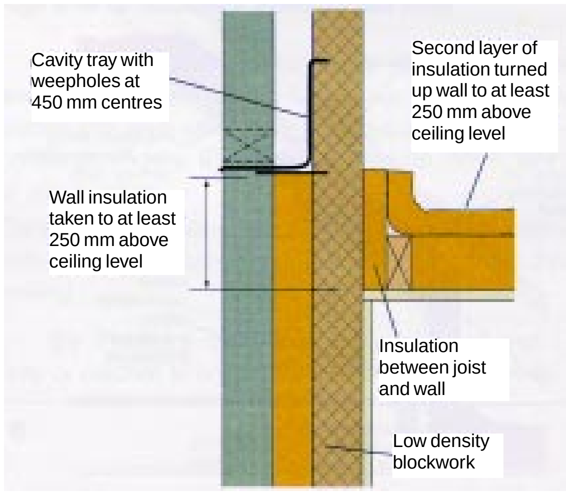
See 2.3(b)

Figure 13 Examples of avoiding thermal bridging at the eaves

2.3(c) At gable walls:

- insulate the gap between the last ceiling joist and the gable wall,
- take both loft and cavity wall insulation at gables to at least 250 mm above ceiling level and use a low density block for the inner leaf (Figure 14).

R **2.3(d)** When adding a pitched roof to an existing flat roof building, introduce thermal insulation as necessary around the roof perimeter to avoid thermal bridging. Where appropriate, follow the advice in *2.3(a)–(c)*.



See 2.3(c)

Figure 14 Avoiding thermal bridging at the gable wall

2.4 Risks associated with electrics

Electrical cables give off heat when in use. Where cables are covered by thermal insulation they may overheat, increasing the risk of short circuit, or fire starting in combustible loose fill and plastics insulation. PVC sheathing to cables can have reduced life expectancy if in direct contact with expanded polystyrene insulants.

High wattage recessed light fittings need to be cooled by a through-flow of air from the building. This air flow can cause condensation problems in the loft.

2.4(a) Fix cables to the structure above the insulation so that they can dissipate heat. Cables that pass through, or are enclosed by, insulation may need to be increased in size, even when in conduit. The circuits most likely to be affected are radial circuits serving cookers, immersion heaters, shower units and socket outlets (see *Appendix A*).

2.4(b) Ensure PVC-insulated cables are not in direct contact with expanded polystyrene insulation. Alternatively, run them in conduit.

2.4(c) Where recessed fittings are to be used, specify those designed for compact fluorescent or low voltage tungsten halogen lamps, and locate them within an enclosure, between the joists to dissipate heat. Seal the enclosure to the roof space, but ventilate to the room if necessary.

2.5 Freezing of water in pipes and cisterns

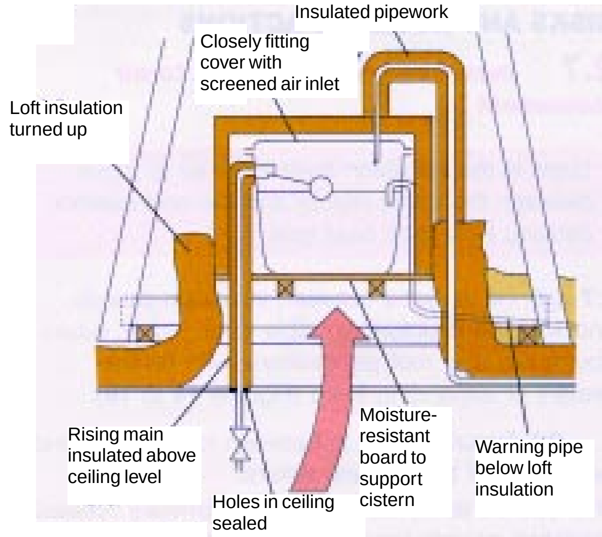
The better insulated the ceiling, the lower the air temperature in the roof space. Water in pipes and cisterns outside the insulated enclosure may freeze and burst pipes if not drawn frequently during cold weather. Subsequent thawing will cause damage to ceilings and furnishings. Condensation on uninsulated pipes or cisterns can damage cistern supports and stain ceilings.

2.5(a) Locate pipes in heated spaces whenever possible, eg below loft insulation or below ceilings. Avoid running hot and cold water pipes closely together since this will warm the cold supply.

2.5(b) Specify pipe insulation for all pipes in unheated roof spaces (Figure 15). The minimum thickness depends on the thermal conductivity of the insulation material (see Appendix B). Where no heat is available from the occupied space, or the building remains unoccupied for long periods during cold weather, install thermostatically controlled trace heaters for pipes and low output heaters for cisterns.

2.5(c) Insulate the top and sides of cold water cisterns in the roof space. Omit insulation from directly under the cistern to allow warmth from below to reach the cistern base. Insulate the gap below the cistern base by turning up the loft insulation against the tank insulation. Where possible, locate the rising main within the insulated enclosure for the tank. Alternatively, insulate it using a closed cell, vapour-resistant material with all joints covered with vapour-resistant tape, or enclose fibrous insulation within a vapour control layer.

Use a moisture-resistant board as the cistern support to avoid damage from any condensation which may form on the outside of the cistern (Figure 15).



See 2.5(b), (c)

Figure 15 Insulated pipes and cisterns in roof space

2.6 Increased heat loss where insulation is not full depth

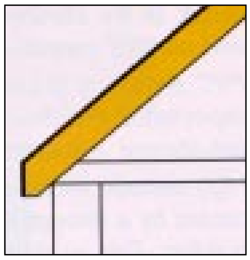
In most applications the loft insulation will be deeper than the ceiling joists. With the joists obscured there is a risk of falling through the ceiling. Access boarding to water services or to storage points may restrict insulation thickness.

2.6(a) To reduce the risk of condensation on the underside of access boarding:

- position the cold water storage tank on a raised platform directly adjacent to the loft hatch, *or*
- use slatted boarding on the access way, *or*
- support panel flooring at least 25 mm above the top of the insulation to allow air movement between the flooring and the insulation (Figure 7).

2.6(b) Insulate the loft hatch to the highest practical level, or choose a proprietary unit with the best available insulation properties.

Pitched roofs with sarking insulation



Characteristics of the construction

The insulation is placed above and between the rafters creating a warm structure and loft space, which does not require to be ventilated, and is particularly suitable for room-in-the-roof construction.

R The insulation method is relevant if the roof covering is to be replaced or an existing roof is to be converted to living space. It is a particularly useful alternative where it is difficult to detail eaves ventilation in a loft insulated at ceiling level.

Associated technical risks

2.7 Increased heat loss due to air movement
2.8 Condensation within the construction
2.9 Condensation at thermal bridges
2.10 Condensation on pipes and ducts
2.11 Fire spread with combustible insulants

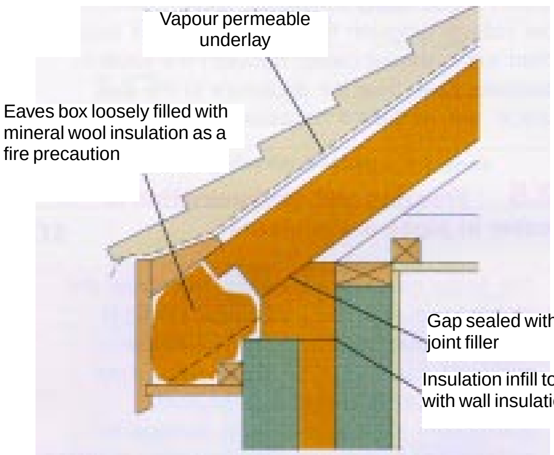
Risks and avoiding actions

2.7 Increased heat loss due to air movement

Gaps in the insulation layer allow air to move between the warm interior and the cold exterior, causing increased heat loss.

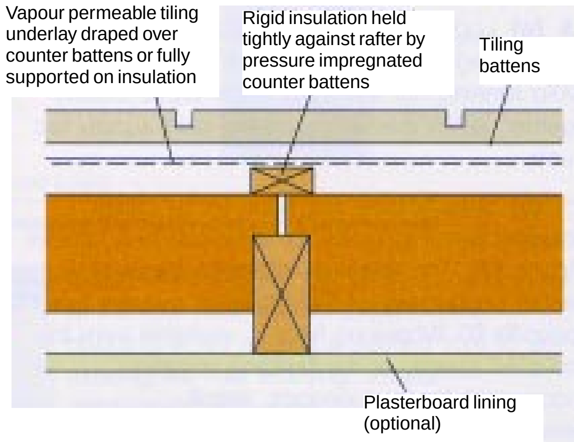
2.7(a) Fill all gaps between insulation boards and with the structure at gable ends, ridge, eaves, abutments and roof penetrations with flexible sealant or expanding foam (Figures 16–18).

2.7(b) Ensure a tight fit between individual insulation boards and between the insulation boards and the rafters. This can be achieved by using proprietary rebated insulation boards (sized to suit standard rafter spacings) as templates when positioning rafters (Figures 17 and 18). Their use also avoids the rafters being forced out of alignment if they are not spaced accurately. Manufacturer's recommendations for taping board joints should be followed.



See 2.7(a), 2.11(a)

Figure 16 Sarking insulation at the eaves



See 2.7(a), (b), 2.8(a), (b)

Figure 17 Section through sarking insulation and rafter

2.8 Condensation within the construction

Water vapour from the internal environment can condense on cold surfaces within the construction if it penetrates the insulation layer and cannot permeate through the tiling underlay.

2.8(a) Follow the manufacturer's guidance on the positioning of the tiling underlay and ensure that battens and counter battens are preservative treated (Figure 17).

2.8(b) Tightly fit the insulation layer as in *2.7(b)* and ensure that a vapour permeable membrane is used as the tiling underlay (Figure 17). Provide an air path, a minimum of 50 mm deep, between the weatherproofing layer and the vapour permeable tiling underlay. This air path should be ventilated to the outside by the equivalent of a 25 mm continuous gap and additional openings at the ridge equivalent to a 5 mm continuous gap.

Alternatively, where a high resistance membrane is used provide a clear 50 mm ventilated air path between this membrane and the insulation.

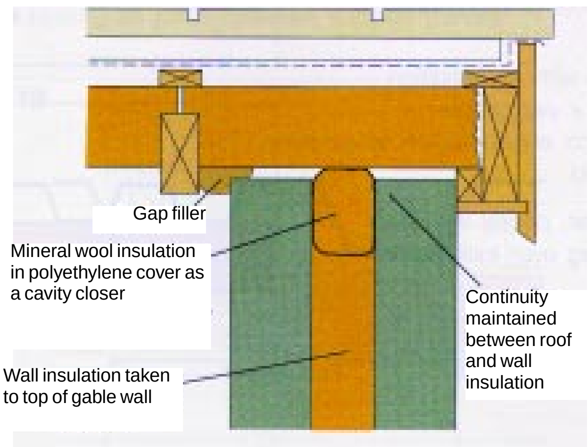
2.8(c) Consider providing a vapour control layer, eg 500 gauge (0.12 mm) polyethylene to inclined ceilings enclosing kitchens, bathrooms and showers.

R Remove any existing loft insulation at ceiling level so that insulation is concentrated at rafter level.

2.9 Condensation at thermal bridges

Gaps or lack of continuity in the insulation create thermal bridges allowing condensation to form on cold surfaces.

2.9(a) Ensure continuity between roof and wall insulation at eaves and verge. Insulate gable walls to link with the roof insulation at the verge (Figure 18).



See 2.7(a), (b), 2.9(a)

Figure 18 Junction of sarking insulation and gable wall

2.10 Condensation on pipes and ducts

Warm moist air within the insulated roof space can condense on the uninsulated, cold surfaces of pipes and ducts which pass through the roof construction and vent to the outside. The condensate can build up to an extent where it may damage the structure and finishes.

2.10(a) Insulate pipes and ducts if it is considered that condensate will cause damage.

2.10(b) Use a closed cell vapour-resistant insulant and wrap joints with vapour-resistant tape, or enclose fibrous insulation within a vapour control layer, to restrict water vapour from reaching the pipe.

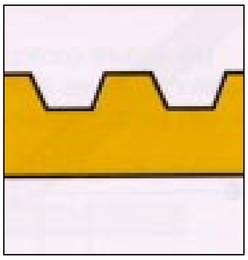
2.11 Fire spread with combustible insulants

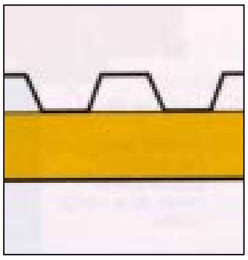
Flame and hot gases can gain access to insulation at eaves and verge where blow lamps are used to burn paint from the associated woodwork. In addition, there is also a risk from candles and barbecues where the roof slope runs close to the ground or to balconies.

2.11(a) Fill the eaves and verge box with non-combustible insulation (Figure 16), and place non-combustible insulation over the party wall to maintain fire separation.

2.11(b) Incorporate intumescent material within those roof ventilators located close to ground or balcony level.

Pitched roofs of profiled sheet





Characteristics of the construction

There are a number of variants of profiled sheet roofing, with descriptors depending on whether the insulation fully fills or partially fills the enclosed void and whether the system is factory or site assembled.

It is generally recognised that in the 'composite' roof the insulation is sandwiched between, and in full contact with, the inner and outer profiled sheets. Composite panels can be formed by injecting insulation between the sheets or can be built up in layers using specially shaped insulants to match the sheet profiles. Composite systems are generally pre-assembled off site but can also be assembled on site. The system normally incorporates vapour-resistant insulants and, if correctly sealed at the joints, needs no separate vapour control layer or breather membrane.

With most 'site assembled' systems insulation having a flat profile is positioned between the inner and outer profiled sheets. This results in unfilled ribs or profiles between the outer sheet and the insulation, which require to be ventilated. Vapour permeable insulation can be used but, since it is necessary to control vapour transfer, a vapour control layer is required. Where there is a calculated risk of condensate forming on the underside of the outer sheet, and subsequently dripping, a breather membrane is also recommended below the outer sheet.

R This type of construction is appropriate when a similar or poorly insulated cladding is at the end of its useful life, or when roofing over existing flat roofs.

Associated technical risks

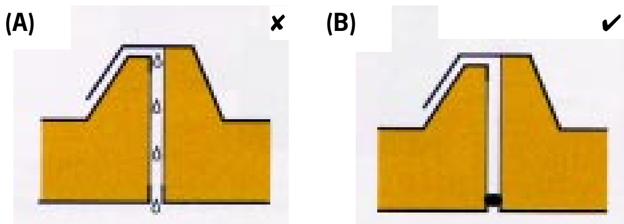
2.12 Condensation within the construction
2.13 Condensation at thermal bridges
2.14 Condensation on internal rainwater downpipes
2.15 Corrosion of sheeting and fixings
2.16 Delamination of fully filled panels

Note: In assessing these risks, consideration should be given to the expected life and use of the building, as well as to the anticipated internal and external environmental conditions.

Risks and avoiding actions

2.12 Condensation within the construction

Under certain internal and external conditions there is a risk that condensation will form on the inner face of the outer sheet, above uninsulated sections of sheeting, ie the ribs. In extreme cases this condensate may subsequently wet the insulation, and corrode fixings and the edges of metal sheet.



See 2.12(a)

Figure 19 (A) Open joint, (B) Joint with seal

2.12(a) Use a composite roof where possible and ensure that:
- extract ventilation is provided close to processes producing water vapour,
- all voids are filled with foamed plastics insulation,
- all joints incorporate an effective vapour seal to prevent moist air reaching the cold overlapping metal sheet (Figure 19A and B).

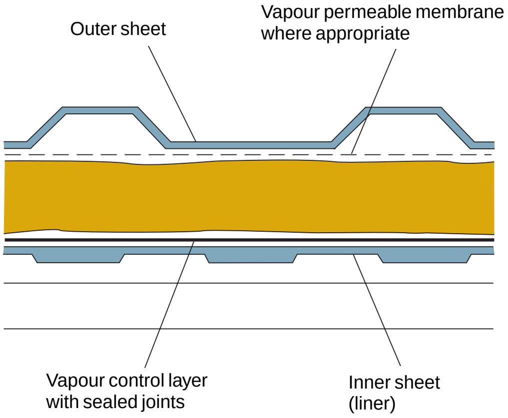
2.12(b) When using a partially insulated roof it is important to:
- provide extract ventilation close to processes producing water vapour,
- incorporate an effective vapour control layer on the warm side of the insulation,
- ensure adequate ventilation through rib voids above the insulation to the external environment.

In addition where, in spite of extract ventilation, there is a risk of high internal humidity levels, eg swimming pools, a vapour permeable membrane is recommended. This should be positioned between the insulation and the outer sheet and should be detailed so that condensate drains to the eaves gutter and is prevented from dripping onto the insulation.

2.12(c) Choose, for preference, a system in which the insulation and internal liner sheet are above the purlins. If purlins need to be concealed, add a separate decorative lining in addition to the insulated construction (Figure 20).

2.12(d) Form a vapour-resistant inner layer by:

- laying a vapour control layer of at least 500 gauge (0.12 mm) polyethylene over the internal liner and sealing the joints of this layer with vapour-resistant tape (Figure 20), *or*
- sealing all joints between liner sheets.



See 2.12(c), (d)

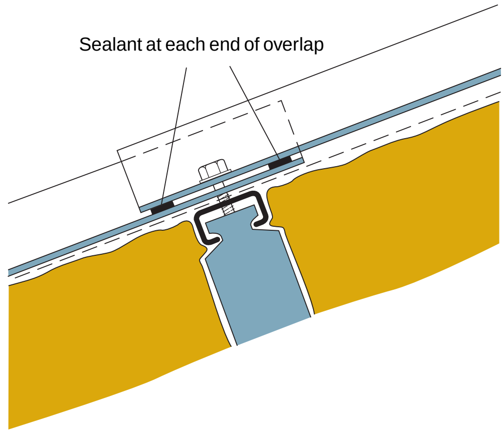
Figure 20 Pitched roof of profiled sheet

2.12(e) Ensure that all fixings to the purlin incorporate a method of sealing the holes against the passage of water vapour (Figure 22).

2.12(f) Form a vapour-tight seal where the vapour control layer is punctured by pipes or ducts.

2.12(g) Use vented filler strips at the eaves and ridge, or at ventilator locations, to allow ventilation of rib voids.

2.12(h) Avoid end laps whenever possible. When this is unavoidable, seal the end lap with two runs of sealant, one at each end of the overlap (Figure 21).



See 2.12(h)

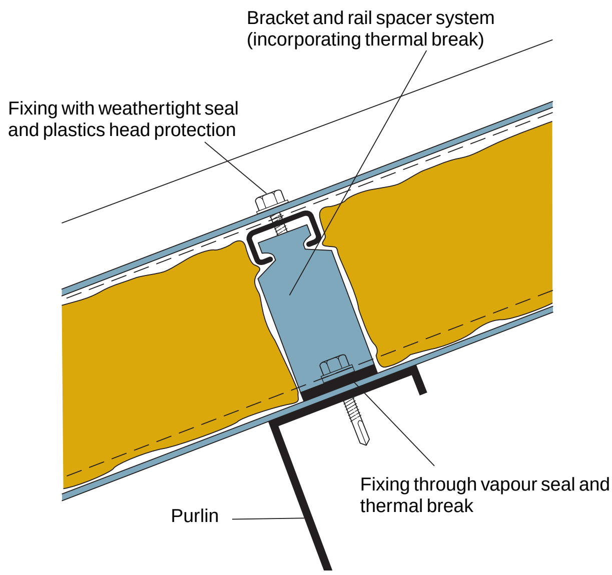
Figure 21 Profiled sheet: sealing at the end laps

2.13 Condensation at thermal bridges

Spacer sections commonly link inner and outer metal components. Junctions and joints of internal gutters can be uninsulated and some types of rooflight and flashings break the continuity of the construction.

2.13(a) Provide extract ventilation close to processes producing water vapour.

2.13(b) Create a thermal break by inserting a non-metallic spacer between the outer profiled sheet and liner sheet (Figure 22).



See 2.12(e), 2.13(b)

Figure 22 Sealing and thermally broken spacer system

2.13(c) Ensure that insulation is positioned between the spacers and liner sheet.

2.13(d) Design the roof to fall to external eaves gutters. Where an internal gutter is specified, ensure that it is insulated and that it includes an effective vapour control layer to restrict water vapour from reaching the cold metal surface. Joints between sections of insulation should be sealed with vapour-resistant tape.

2.13(e) Specify rooflights that satisfy the thermal requirements and provide a thermally broken junction with the cladding system.

2.14 Condensation on internal rainwater downpipes

The walls of rainwater downpipes and other pipes that penetrate the roof (ie stack vents) present a cold surface on which moisture from the internal air can condense. This can run down and damage internal finishes.

2.14(a) Insulate internal rainwater downpipes and other pipes that penetrate the roof if they pass through spaces with a high humidity. Use a closed cell vapour-resistant insulant and wrap joints with vapour-resistant tape or enclose fibrous insulation within a vapour control layer to restrict water vapour from reaching the pipe.

2.15 Corrosion of sheeting and fixings

The coating on the underside of the sheeting is often less corrosion-resistant than the external coating, making the underside susceptible to corrosion in high condensation risk situations. Moisture held between the sheets can accelerate corrosion of fixings.

2.15(a) Choose external sheeting, coated on the underside, which, in high condensation risk situations, is capable of resisting corrosion.

2.15(b) Choose fixings of stainless steel for high-risk buildings. Where the internal relative humidity is not likely to rise above 65%, or for buildings designed for a short lifetime, carbon steel fixings with a protective coating are adequate.

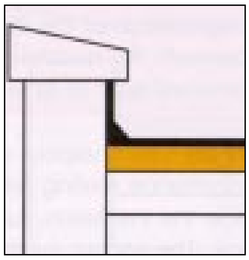
2.16 Delamination of fully filled panels

Where fully filled panels, which rely on full bonding of the insulation to the outer and inner sheets, are subjected to extreme structural or thermal stresses this can result in cracking or delamination of the insulation. This can result in bowing and may have durability implications for the system.

2.16(a) Seek guidance and assurance from the manufacturer that the intended structural loading can be adequately carried by the system.

2.16(b) Choose light rather than dark colours for external finishes, whenever possible, to minimise the risk of thermal bowing.

Flat roofs with warm deck



Characteristics of the construction

The insulation is placed above the roof deck, but below the weatherproof membrane. Normally, there should be no insulation below the deck. Ventilation is not required since the insulation is bedded on a continuous vapour control layer. This method is used above timber, concrete and metal structural decks.

R This insulation method is appropriate when the weatherproof membrane of a concrete or timber warm deck flat roof has failed and needs to be renewed or where the membrane is in good condition, but the insulation needs to be upgraded. For timber flat roofs, the method may also be used to replace a cold deck construction where only the structural joists are in a satisfactory condition.

Associated technical risks

2.17 Fatigue of weatherproof membrane
2.18 Insulant damaged by heat during construction
2.19 Fire spread from a melting or burning weatherproof membrane and combustible insulation
2.20 Condensation within the construction
2.21 Condensation at thermal bridges

Risks and avoiding actions

2.17 Fatigue of weatherproof membrane

Placing insulation directly below the weatherproof membrane will increase the membrane's surface temperature fluctuations. On sunny days the insulation slows the heat flow to the deck causing a build up in the membrane's surface temperature. At night the membrane has a lower surface temperature as it loses heat by radiation to the night sky.

2.17(a) For built-up roofing use high performance membranes that can accommodate stresses and remain flexible over a wide temperature range. Partial bonding of the first layer can help distribute any stresses evenly beneath the weatherproof membrane.

2.17(b) Protect bitumen-based weatherproof membranes with a solar-reflective finish to reduce thermal stress.

2.17(c) For polymeric single-ply materials, follow manufacturers' recommendations on bonding and fixing.

2.17(d) Provide sufficient falls for membranes of all kinds to ensure drainage and avoid ponding, and to reduce stresses on the membrane during heating and cooling.

2.18 Insulant damaged by heat during construction

Some insulation materials can be damaged by high temperatures when laying asphalt or using hot bitumen to bond built-up felt roofing.

2.18(a) Avoid damage to expanded polystyrene insulation by:

- protecting the insulation with a layer of corkboard or bitumen-impregnated fibreboard, *or*
- using a composite insulation board with integral heat protection.

2.19 Fire spread from a melting or burning weatherproof membrane and combustible insulation

A fire source inside the building may cause cellular plastics insulants and weatherproof membranes laid directly onto unprotected metal decks to melt and/or decompose. The flammable gases generated and any molten materials, eg bitumen or polystyrene, may penetrate joints in the roof deck and increase the spread of fire below.

2.19(a) Choose a non-combustible insulant or place a gypsum board between the metal deck and cellular plastics insulation. Alternative methods of improved fire protection for insulated roof decks are available and could be usefully discussed with a fire expert.

2.20 Condensation within the construction

If water vapour is able to penetrate the insulation, it can condense on the cold weatherproof membrane and cause degradation of the insulation and bubbling beneath the weatherproof membrane, which in time will lead to its breakdown.

2.20(a) Lay a vapour control layer of high performance roofing felt immediately below the insulation, fully supported by the roof deck. The vapour control layer should be fully bonded to the deck and have all laps sealed with hot bitumen.

At the perimeter, the vapour control layer should be turned back 150 mm over the insulation and bonded to the weatherproof membrane (Figures 23 and 24). Where insulation is compressible, it should have a dense topping to support the weatherproof membrane if roof access is anticipated.

2.20(b) In timber construction, restrict the passage of moist air from the structural roof void to the eaves box by installing a vertical strip of closed cell rigid insulation and sealing all gaps, eg with expanding foam, to minimise condensation on cold surfaces within the eaves box.

R When it is not possible to avoid having some insulation below the deck, ensure that the greater thermal resistance is on the cold side of the deck.

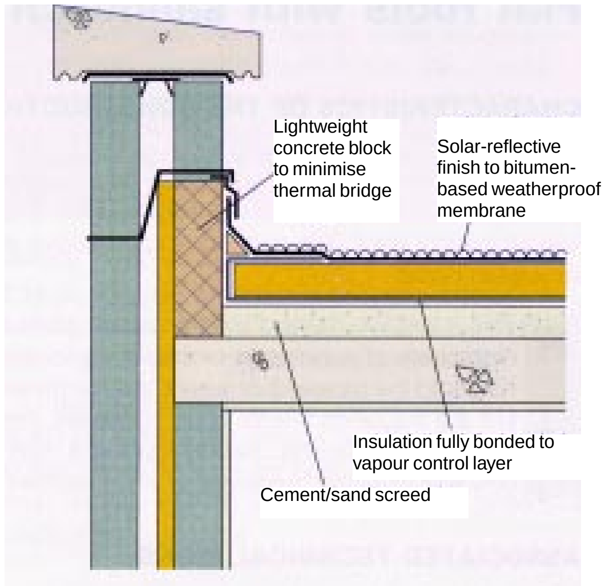
2.21 Condensation at thermal bridges

Where the continuity of the insulating layer is broken, particularly at the roof/wall junction and where pipes penetrate the roof, a thermal bridge occurs and there is the risk of surface condensation.

2.21(a) To avoid a thermal bridge at the roof/wall junction and at changes in level:
- maintain continuity of insulation, *or*
- overlap roof and wall insulation and introduce insulation material between (Figures 23 and 24).

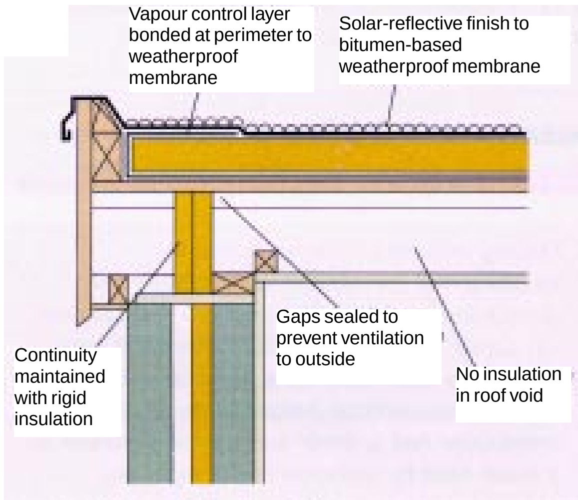
When the insulation is above a concrete deck, breaks in the insulation at upstands and plinths within the main roof area will not create a serious risk of surface condensation.

2.21(b) In timber roof construction, insulate the perimeter of the structural roof void to maintain continuity between roof and wall insulation (Figure 24).



See 2.20(a), 2.21(a)

Figure 23 Warm deck roofing above a concrete structure



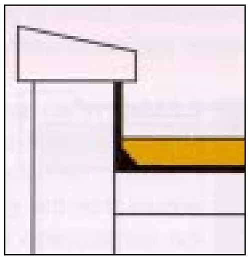
See 2.20(a), 2.21(a), (b)

Figure 24 Warm deck roofing above a timber structure

2.21(c) Insulate internal rainwater downpipes and other pipes that penetrate the roof if they pass through spaces with a high humidity and if any condensate will damage the structure or internal finishes.

Use a closed cell vapour-resistant insulant and wrap joints with vapour-resistant tape or enclose fibrous insulation within a vapour control layer to restrict water vapour reaching the pipe.

Flat roofs with inverted warm deck



Characteristics of the construction

The insulation is placed above the weatherproof membrane. It is protected from UV degradation and held down against wind uplift by a ballast layer and edge restraint. A filter layer is laid immediately below the ballast. The method can be used above concrete, metal and timber structural decks.

Concrete decks are capable of supporting a ballast layer of paving slabs or pebbles. With lightweight decks, that cannot carry heavy ballast, use a permeable sheet topping to restrain tongued and grooved insulation boards to create a fully interlocking layer. Care needs to be taken with timber decks to ensure that the structure is capable of supporting the inverted roof system.

For new construction, there should be no materials with a high thermal insulation value below the deck.

R This method may be used when the existing construction is to be renewed or when it is necessary to upgrade an existing poorly insulated construction. When upgrading an existing roof, it will be necessary to check:

- the condition of the existing weatherproofing membrane,
- the thermal resistance of any insulation previously installed below the weatherproof membrane, and
- the ability of the roof to support the proposed increased load.

Associated technical risks

2.22 Increased heat loss due to rain cooling
2.23 Condensation through chilling of lightweight metal decking
2.24 Condensation within the construction
2.25 Condensation at thermal bridges
2.26 Degradation of the insulant
2.27 Abrasion of the weatherproof membrane

Risks and avoiding actions

2.22 Increased heat loss due to rain cooling

The weatherproof membrane of an inverted roof remains close to the internal building temperature throughout the year. However, cold rainwater, which percolates through the ballast and joints in the insulation, will flow over this relatively warm surface causing increased heat loss.

2.22(a) Add 20% to the insulation thickness required to meet Building Regulation requirements to offset the intermittent cooling effect of rain.

2.23 Condensation through chilling of lightweight metal decking

There is a risk of localised condensation on the underside of lightweight decks if melting snow or cold rainwater percolates through the insulation layer and chills the deck. The risk is greatest where the internal temperature and relative humidity are high. Concrete roof decks, because of their high thermal mass, are less affected by chilling and do not normally suffer from surface condensation.

2.23(a) Restrict the amount of rainwater able to reach the weatherproof membrane by tightly butting insulation boards and trimming them tightly around projections and at upstands. The use of insulation boards with an overlapping edge profile is advantageous.

2.24 Condensation within the construction

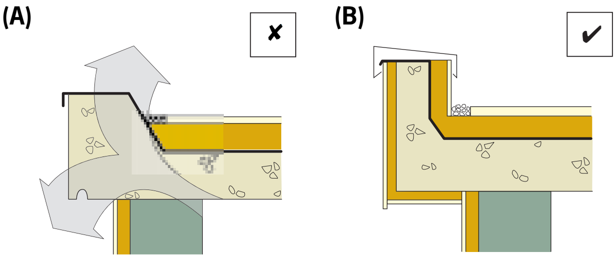
Where there is too high a proportion of the total thermal resistance below the weatherproof membrane, there is a risk of condensation within the construction.

R **2.24(a)** When some insulation is needed below the deck or previously installed insulation remains in the construction, ensure that the greater thermal resistance of the construction is above the weatherproof membrane.

2.25 Condensation at thermal bridges

Where the continuity of the insulating layer is broken, particularly at the roof/wall junction and where pipes penetrate the roof, a thermal bridge occurs and there is a risk of surface condensation.

2.25(a) Overlap wall and roof insulation to extend the thermal bridge path, if necessary by adding thermal insulation to edge beams to achieve continuity with external insulation (Figure 25).

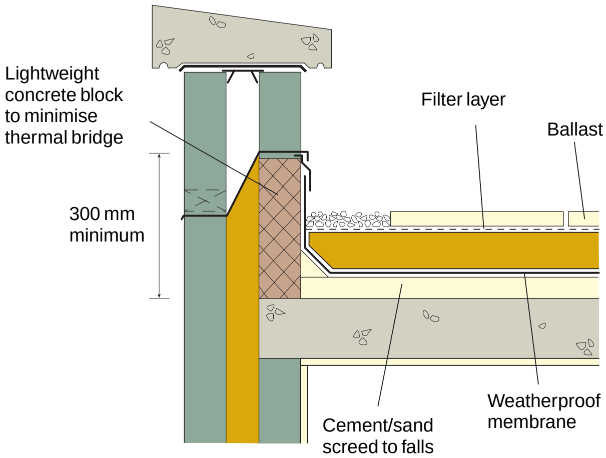


See 2.25(a)

Figure 25 Achieving continuity with external insulation

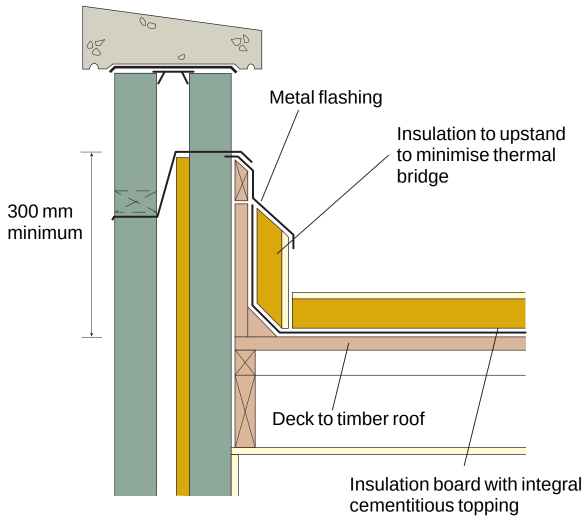
2.25(b) Insulate parapet upstands or use a lightweight concrete block in the thermal bridge path between the wall and roof insulation (Figures 26 and 27).

2.25(c) Insulate internal rainwater downpipes and other pipes that penetrate the roof if they pass through spaces with a high humidity and if any condensate will damage the structure or internal finishes. Use a closed cell vapour-resistant insulant and wrap joints with vapour-resistant tape or enclose fibrous insulation within a vapour control layer to restrict water vapour from reaching the pipe.



See 2.25(b)

Figure 26 Inverted warm deck above a concrete structure



See 2.25(b)

Figure 27 Inverted warm deck above a timber structure

2.26 Degradation of the insulant

Being above the weatherproof membrane, the insulant is subject to degradation from freeze/thaw cycles, wetting and UV light if ballast moves. The insulation can also be damaged by chippings on existing roof coverings.

2.26(a) Use an insulant which has low water absorption and is frost resistant.

2.26(b) Ensure that plastics foam insulants are not exposed to UV light. Use flashings to protect the insulant at upstands.

Provided the ballast layer is continuous, it will protect the insulant from UV degradation. Where necessary, increase the gravel size, use paving slabs in vulnerable areas, or increase the parapet height.

R **2.26(c)** If any chippings remain bonded to an existing weatherproof membrane, remove as many as possible and lay a cushioning layer of polyethylene foam below the insulation.

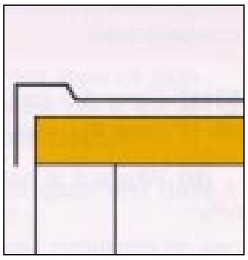
2.27 Abrasion of the weatherproof membrane

Grit washed down between the insulation boards can cause abrasion and eventually puncture weatherproof membranes, particularly single-layer membranes.

2.27(a) Lay a separating layer above single layer membranes. Turn up this separating layer at upstands.

2.27(b) Place a suitable geotextile filter membrane above the insulation and below the ballast layer. Turn up this filter membrane at upstands.

Flat roofs with cold deck



Characteristics of the construction

The insulation is placed at ceiling level with a void ventilated to the outside between the insulation and the deck. It should be considered only for timber construction. With increased levels of insulation it may prove impractical to achieve the desired thermal performance and the required ventilation without increasing the depth of the joists by additional battening. The preferred option is to provide a warm deck flat roof.

The cold deck roof is considered a poor option in the temperate, humid climate of the UK, where sufficient ventilation may not be achieved in sheltered locations or in windless conditions, even when the roof is correctly designed.

R It is usually not possible to upgrade the thermal insulation value of an existing cold deck roof. The preferred option is to convert it to a warm deck flat roof.

Associated technical risks

2.28 Condensation within the roof
2.29 Condensation at thermal bridges

Risks and avoiding actions

2.28 Condensation within the roof

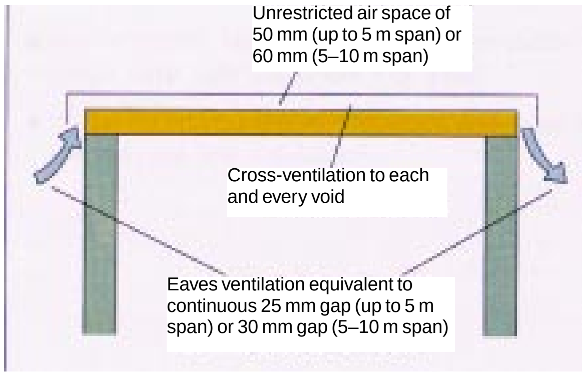
If humid air, which enters the roof from inside or outside the building, is not ventilated away, moisture can condense on the underside of the roof deck and drip onto the insulation, damaging ceilings and eventually the timber structure. It can also cause early corrosion of metal roof fixings and coverings. The risk of condensation is high.

2.28(a) Restrict humid air from entering the roof space by providing a continuous vapour control layer of 500 gauge (0.12 mm) polyethylene across the roof area, on the warm side of the insulation. Lap and tape the joints of the vapour control layer and seal to the wall at the edges.

To reduce the risk of puncturing the vapour control layer:
- avoid running services within the roof structure, *or*
- form a services zone immediately above the ceiling (Figure 29).

2.28(b) Where services pass vertically through the roof (eg stack vents), seal the joint between the pipe and the ceiling (allowing for thermal movement) and seal the vapour control layer to the pipe.

Alternatively, avoid taking services through the roof structure. In the case of stack vents, terminate the pipe, where possible, with an air admittance valve and locate it in a ventilated duct to avoid damage.



See 2.28(c), (e), (f)

Figure 28 Ventilation requirements for cold deck flat roofs

2.28(c) Provide cross-ventilation to each and every void to the outside air, via an unrestricted air space above the insulation (Figures 28 and 29).

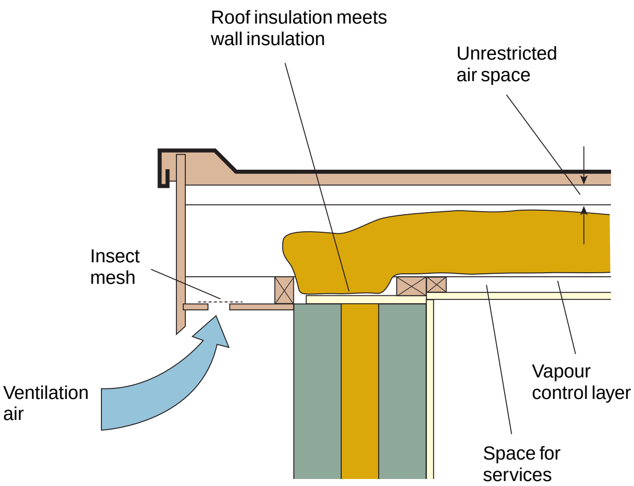
2.28(d) Do not use the cold deck construction if cross-ventilation is restricted or blocked, eg by solid strutting or cavity barriers, or if the structure spans between parapet or abutment walls.

2.28(e) Provide ventilation openings to each discrete cavity on opposite sides of the roof equivalent to a continuous 25 mm gap (for spans up to 5 m) or 30 mm gap (for 5–10 m spans), or in total, 0.6% of the roof plan area, whichever is the greater (Figure 28).

2.28(f) Provide an unrestricted air space above the insulation of at least 50 mm (for spans up to 5 m) or 60 mm (for 5–10 m spans) (Figure 28).

2.28(g) Prevent the entry of insects by placing 3–4 mm mesh across ventilation apertures (Figure 29). Ensure that the mesh is taken into account when calculating the ventilation area.

2.28(h) Do not locate flue outlets less than 850 mm below perimeter vents or plastics gutters.



See 2.28(a), (c), (g), 2.29(a), (b)

Figure 29 Avoiding vapour transfer to the roof space and thermal bridging at the eaves

2.29 Condensation at thermal bridges

Where the continuity of the insulating layer is broken, particularly at the roof/wall junction and where pipes penetrate the roof, a thermal bridge occurs and there is the risk of surface condensation.

2.29(a) Carry the roof insulation over the wall plate to meet the wall insulation (Figure 29).

2.29(b) Where it is necessary to close the wall cavity:

- use a low density concrete block as a closer, but only if no significant differential movement between inner and outer leaves is anticipated, *or*
- use mineral fibre in a polyethylene cover as a cavity closer to avoid any damage from differential movement between, for example, block inner and brick outer leaves, *or*
- use a thin board, eg calcium silicate, as a cavity closer, provided it is fixed in a way that will not result in problems if there is differential movement between inner and outer leaves (Figure 29).

Do not use dense masonry as a cavity closer. Where cavity closers are required to perform as cavity fire barriers they must comply with building regulations.

2.29(c) Insulate internal rainwater downpipes and other pipes that penetrate the roof if they pass through spaces with a high humidity and if any condensate will damage the structure or internal finishes. Use a closed cell vapour-resistant insulant and wrap joints with vapour-resistant tape, or enclose fibrous insulation within a vapour control layer, to restrict water vapour from reaching the pipe.

Quality control checks for roofs

Pitched roofs with ventilated roof spaces

- Is the insulation laid without gaps and does it link with the wall insulation?
- Is ventilation provided where specified and are routes from the outside to the appropriate cavity or void clear?
- Is a clear ventilation route provided between the weatherproofing layer and vapour permeable underlay above an unventilated loft space?
- Are cavity closers of low conductivity material which, when built in, will not cause problems in the event of differential movement between the leaves of the cavity wall?
- Are all holes for services or penetrations through the ceiling or through vapour control layers effectively sealed against air leakage and water vapour ingress?
- Are cold water cisterns insulated on the top and sides?
- Is all pipework insulated and are thermostatic trace heaters (when installed) functioning properly?
- Are electric cables above the insulation or correctly rated when in contact with, or passing through, thermal insulation?

Pitched roofs with sarking insulation

- Is the insulation fitted without gaps and linking with wall insulation?
- Is a permeable membrane used as the tiling underlay?
- Is ventilation provided between the weatherproofing layer and a vapour permeable underlay?
- Is ventilation provided below a high resistance membrane?

Pitched roofs of profiled sheet

- Is a continuous vapour control layer with lapped and taped joints fitted above the internal liner in partially filled roofs?
- Where necessary, is a breather membrane placed above the insulation in partially filled roofs and does it drain into the gutter?
- Is the ventilation route through rib voids clear at eaves, ridge or appropriate location in partially filled roofs?
- Are fixings of specified type with all washers, seals, etc. correctly assembled?

Flat roofs with warm deck

- Is a continuous vapour control layer of high performance felt bonded to the deck, turned up at the perimeter and all joints sealed?
- Is the insulation fitted without gaps and does it link with the wall insulation?
- Is the insulation being kept dry until the roof is sealed?
- Is expanded polystyrene protected from hot bitumen and mastic asphalt with fibreboard or corkboard?

Flat roofs with inverted warm deck

- Is drainage from the roof effective?
- Do all insulation boards fit tightly together and is any upstand insulation in position?
- Is the ballast layer being applied soon after fitting the insulation?
- Is a filter membrane laid beneath the ballast layer?
- Is a separating layer placed above single-layer weatherproof membranes?
- Have steps been taken to avoid wind scouring of pebble ballast?
- Has the insulation been protected from UV light?

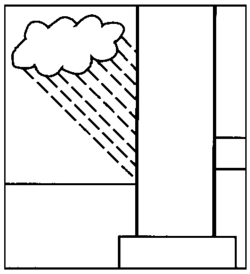
Flat roofs with cold deck

- Have risks been fully assessed for this form of construction?
- Is the vapour control layer continuous and fully sealed with no penetrations for services?
- Has adequate ventilation been provided?
- Are ventilation openings and cross-ventilation routes clear over the whole roof area?
- Is the insulation fitted without gaps and does it link with the wall insulation?

3

Walls

Rain penetration through cavity and solid walls



Characteristics of the construction

This sub-section covers a single technical risk which is common to all insulated masonry walls. The masonry may be solid or cavity construction and of facing masonry or masonry with an additional protective finish such as render or tile hanging. Insulation may be within the cavity, within a timber frame or as internal or external insulation applied to the wall surface.

R This guidance is appropriate when adding extensions or when upgrading the thermal performance of existing masonry walls. The condition and history of existing walls can influence the choice of insulation.

Associated technical risk

3.1 Rain pentration through masonry walls

Note: This technical risk is referred to in all subsequent sub-sections of the Walls section to avoid repeating the issues.

Risk and avoiding action

3.1 Rain penetration through masonry walls

Rainwater will penetrate the outer leaves of masonry walls under certain conditions of driving rain. This can lead to moisture reaching the inside resulting in reduced thermal performance and damage to the wall and decorations.

The performance of the wall in resisting water crossing the cavity is affected by its exposure to wind-driven rain; the presence of a finish or cladding which protects the wall and the quality of the design, specifications and workmanship.

Moisture transmission to the inner leaf of cavity walls is more likely where walls contain building defects and cavity insulation.

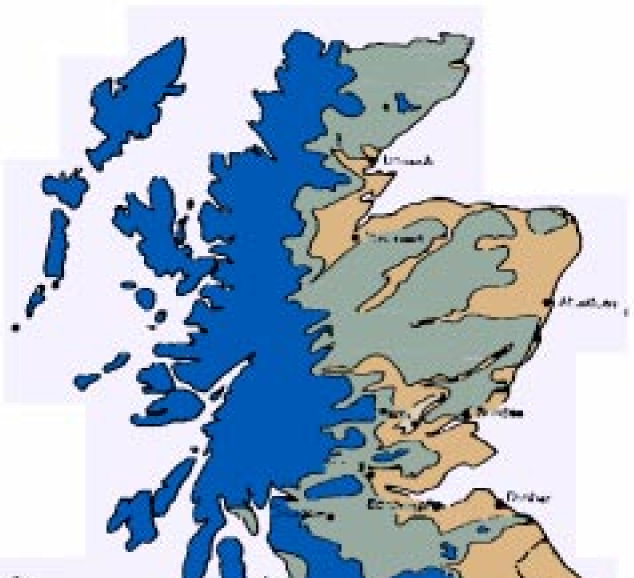
3.1(a) Follow the procedures given in Figure 30 and below to minimise the risk of rain penetration.

- Follow the calculation or assessment procedures in current British or CEN standards or third-party certificates appropriate to the wall construction, location and insulation measure. Where appropriate, ensure that the insulation is installed in accordance with these standards or certificates by registered installers, *or*
- Follow the simplified procedure on the following pages for walls up to 12 m high.

R **3.1(b)** Follow the inspection, assessment and installation procedures in relevant British or CEN standards or third-party certificates.

	Exposure zones	Approximate wind-driven rain* (litres/m^2 per spell)
1	Sheltered	less than 33
2	Moderate	33 to less than 56.5
3	Severe	56.5 to less than 100
4	Very severe	100 or more

* Maximum wall spell index derived from BS 8104



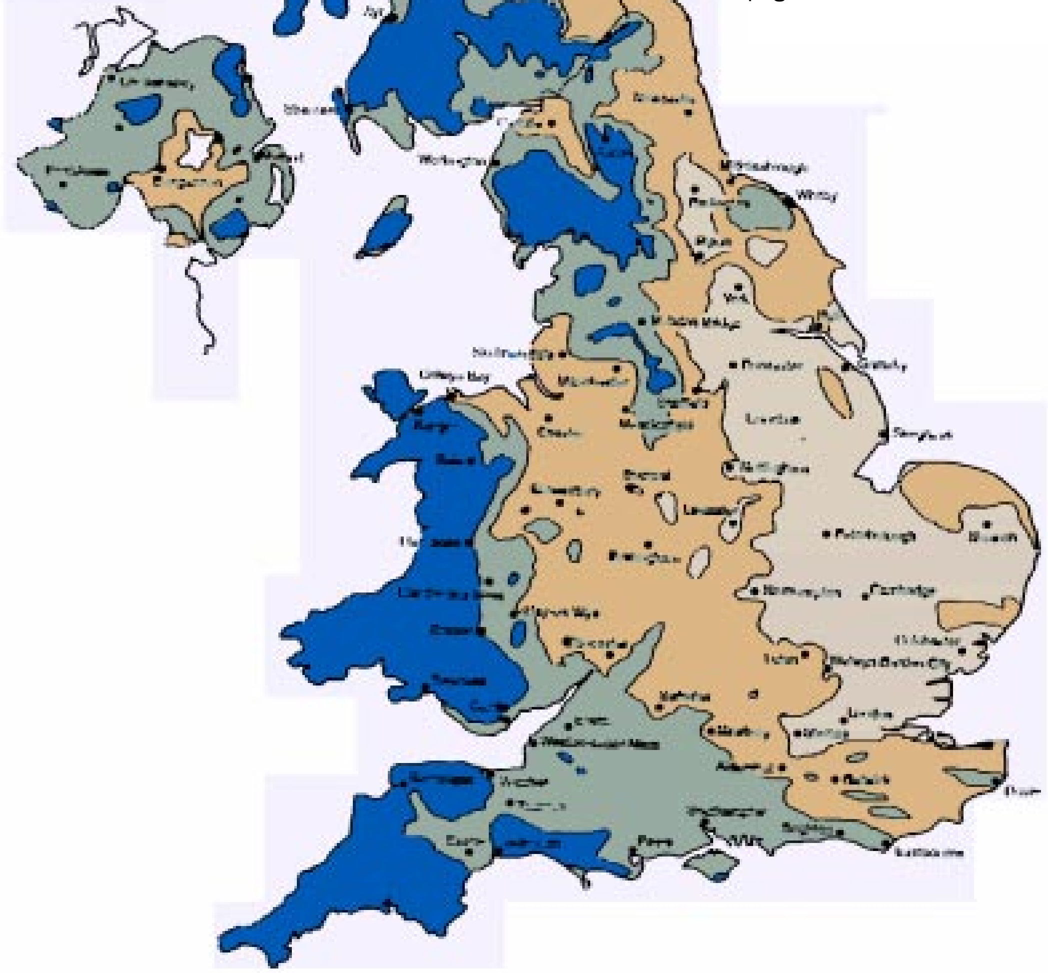


Figure 30 UK exposure zones

Determining the suitability of proposed wall constructions

- Determine the national exposure zone from the map on this page and apply it to Table 1 on page 28. Where necessary, modify the zone to allow for the features given below, or local knowledge and practice.
- Add one to the map zone where conditions accentuate wind effects such as on open hillsides or in valleys where the wind is funnelled onto the wall.
- Subtract one from the map zone where walls are well protected by trees or buildings or do not face the prevailing wind.

Note:
The wind-driven rain index can be more accurately calculated from the large scale maps and correction factors given in BS 8104, then interpreted using the values in the key to the map above and Table 1, page 28.

Table 1 Maximum recommended exposure zones for insulated masonry walls. See guidance notes below

Wall construction		Maximum recommended exposure zone for each construction						
Insulation method	**Min. width of filled cavity or clear cavity (mm)**	**Impervious cladding**		**Rendered finish**		**Facing masonry**		
		Full height of wall	**Above facing masonry**	**Full height of wall**	**Above facing masonry**	**Tooled flush joints**	**Recessed mortar joints**	**Flush sills and copings**
Built-in full fill	50	4	3	3	3	2	1	1
	75	4	3	4	3	3	1	1
	100	4	4	4	3	3	1	2
	125	4	4	4	3	3	1	2
	150	4	4	4	4	4	1	2
Injected fill not UF foam	50	4	2	3	2	2	1	1
	75	4	3	4	3	3	1	1
	100	4	3	4	3	3	1	1
	125	4	4	4	3	3	1	2
	150	4	4	4	4	4	1	2
Injected fill UF foam	50	4	2	3	2	1	1	1
	75	4	2	3	2	2	1	1
	100	4	2	3	2	2	1	1
Partial fill								
Residual 50 mm cavity	50	4	4	4	4	3	1	1
Internal insulation								
Clear cavity 50 mm	50	4	3	4	3	3	1	1
Clear cavity 100 mm	100	4	4	4	4	4	2	2
Fully filled cavity 50 mm	50	4	3	3	3	2	1	1
Fully filled cavity 100 mm	100	4	4	4	3	3	1	2

Refer to Figure 31 for interpretation of cladding and render above facing masonry.

Guidance notes to Table 1

Build quality
- Where the construction quality cannot be relied on or guaranteed, consider reducing the maximum recommended exposure zone by one category.

Climate change
- Where there is concern over the increased incidence of wind-driven rain, particularly with full or partial cavity fill, consider increasing the map zone value by one category, ie a location currently assessed as zone 3 (Severely exposed) could be considered as zone 4 (Very severely exposed). This modification should only be considered where there is increased local exposure, eg hillside location, urban fringe or multi-storey construction. Alternatively, provide additional protection in the form of rainscreen cladding to the outer face of the wall.

External insulation
- External insulation systems, which incorporate 65 mm or more of insulation or incorporate a 50 mm clear cavity and an effective external cladding, are generally suitable in all exposure categories. However, reference should be made to manufacturers and any third-party certification guidance on exposure suitability.

Cavities
- Cavities to be not less than the stated width and free of obstructions which will transmit water towards the inner leaf.

Solid masonry
- Internally insulated masonry walls to be at least 328 mm thick if of brickwork, 250 mm if of aggregate blockwork and 215 mm if of autoclaved aerated concrete blockwork with a notional cavity between the masonry and the insulation.

Overhangs
- Sills, copings, string courses and drips below cladding or render to project at least 50 mm and incorporate a throating (Figure 32). Flush sills and copings give no protection to the wall below.
- Overhangs at eaves and verges to be at least 50 mm and incorporate a throating. The greater the overhang, the greater the protection (Figure 31).

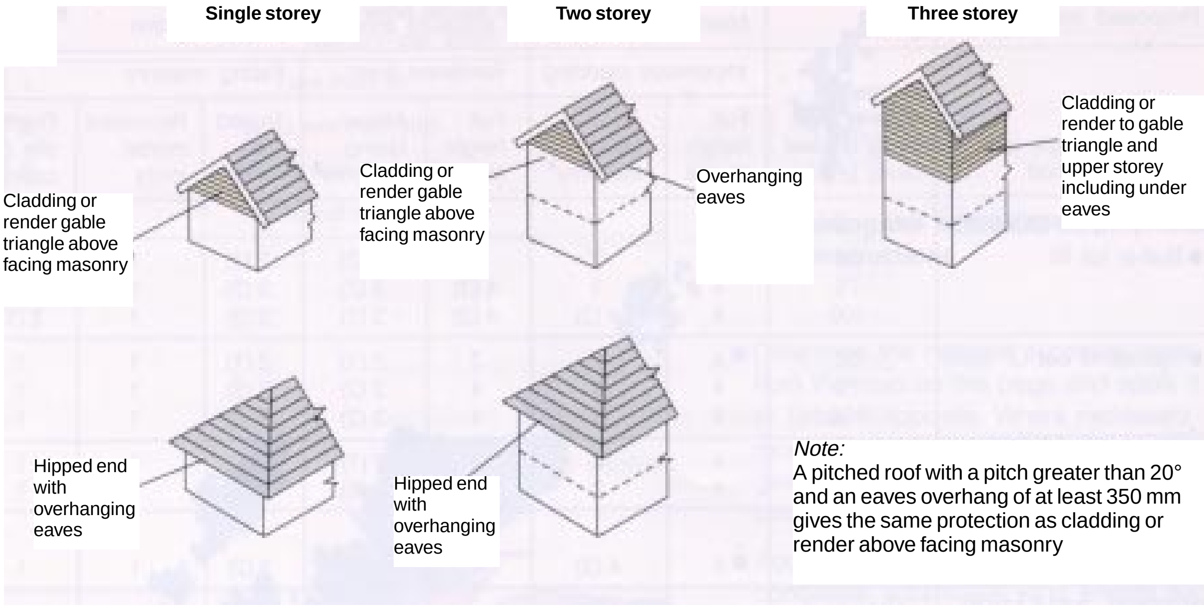
Stop ends
- Watertight stop ends to be secured at the ends of all cavity trays or lintels which are intended to act as cavity trays to prevent water discharging from the ends into the cavity (Figure 34).
- For complicated situations, building sequence to be considered and clear drawings, preferably isometric, provided to obtain pre-formed cavity trays and stop end profiles.

Cavity trays
- Cavity trays to be provided:
  - at all interruptions which are likely to direct rainwater across the cavity, such as rectangular ducts, lintels and recessed meter boxes,
  - above cavity insulation which is not taken to the top of the wall, unless that area of wall is protected by impervious cladding,
  - above lintels in walls in exposure zones 4 and 3 and in zones 2 and 1 where the lintel is not corrosion-resistant and intended to function as its own cavity tray,
  - continuously above lintels where openings are separated by short piers,
  - above openings where the lintel supports a brick soldier course.
- Cavity trays to rise at least 140 mm from the outer to the inner leaf, to be self-supporting or fully supported, and have joints lapped and sealed. The rise across the cavity should be at least 100 mm (Figure 33).

Weepholes
- Weepholes to be installed at not more than 900 mm centres to drain water from cavity trays and from the concrete cavity infill at ground level. When the wall is to be cavity filled, it is advisable to reduce this spacing.
- At least two weepholes to be provided to drain cavity trays above openings.
- Provide means of restricting the entry of wind-driven rain through weepholes in walls in exposure zones 3 and 4, including at ground level.

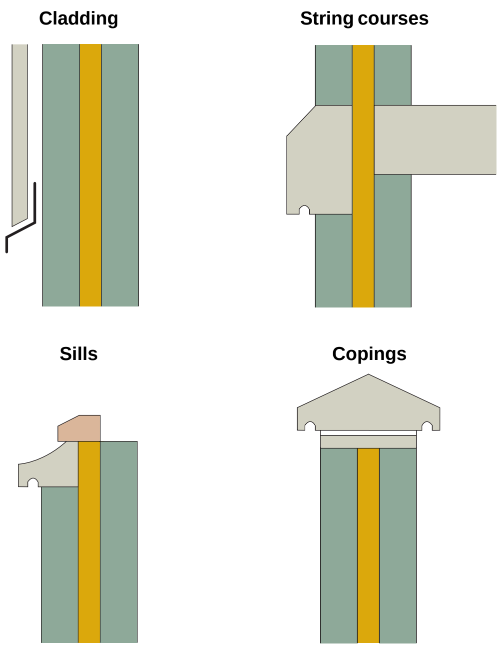
Mortar and render
- A mortar mix whose strength is compatible with the strength and type of masonry unit must be specified to minimise cracking, especially for concrete and calcium silicate units.
- Tooled mortar joints, either bucket handle or weathered, to be used. Recessed or raked joints to be used only in exposure zone 1 with 50 mm clear cavity, or zone 2 with 100 mm clear cavity.
- Render to be appropriately specified and applied to the correct backing material to minimise cracking.

Third-party certification
- Built-in cavity fill must have third-party certification and be installed in accordance with manufacturers' instructions.
- Injected cavity fill must have third-party certification and be installed under an approved surveillance scheme.
- External insulation must have third-party certification for use on solid walls in specified exposure zones.



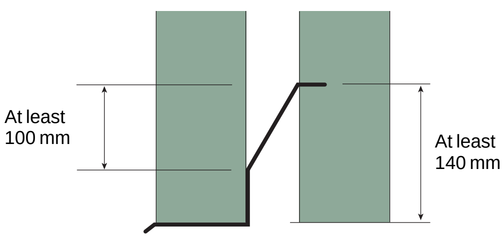
See notes to Table 1

Figure 31 Interpretation of walls with impervious cladding or render above facing masonry



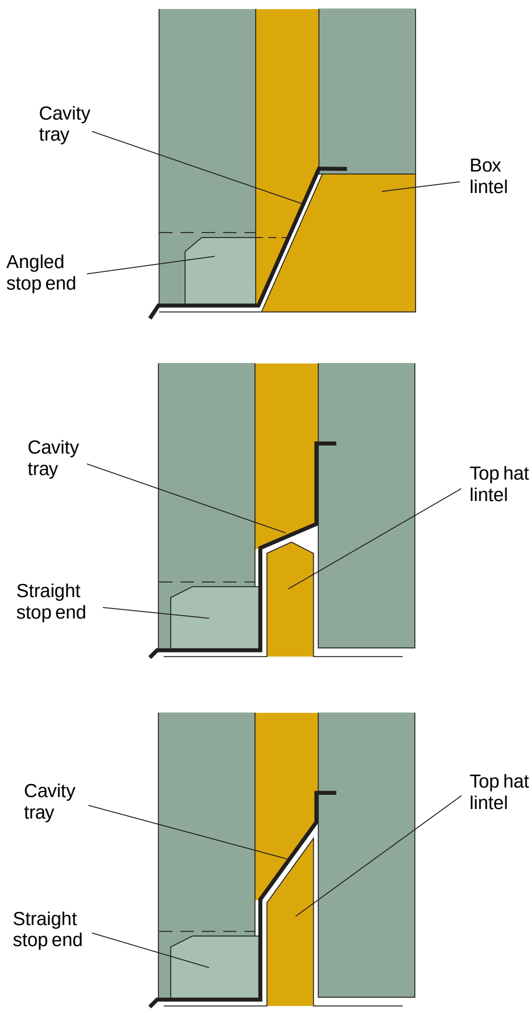
See notes to Table 1

Figure 32 Masonry protected by overhangs



See notes to Table 1

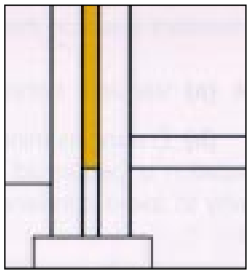
Figure 33 Minimum dimensions for cavity trays



See notes to Table 1

Figure 34 Cavity tray and stop end profiles above lintels

Masonry cavity walls



Characteristics of the construction

This sub-section covers those technical risks common to all insulated walls which have a masonry outer leaf. The outer leaf may be of facing masonry or masonry with an additional protective finish such as render or tile hanging. The cavity may contain insulation.

R This guidance is appropriate when adding extensions or when upgrading the thermal performance of existing masonry walls.

Associated technical risks

3.2 Frost and/or sulfate attack on the outer leaf
3.3 Condensation at thermal bridges
3.4 Condensation within the construction
3.5 Increased heat loss due to air movement
3.6 Spread of fire gases in the wall cavity
3.7 Cracking of plaster due to shrinkage of lightweight blockwork

Note: *For guidance on avoiding rain penetration, refer to section 3.1. Thermal bridging at the junctions of walls with other elements is covered in the appropriate sections on Roofs, Windows and Floors.*

Risks and avoiding actions

3.2 Frost and/or sulfate attack on the outer leaf

The main factors affecting frost attack are the degree of exposure to wind-driven rain combined with the frequency of freeze/thaw cycles and the frost resistance of the masonry.

The main factors affecting sulfate damage to mortar are the length of time the masonry is wet, the presence and type of soluble salts in the masonry units and the type of cement used for the mortar.

The changes in temperature and moisture content due to increased insulation are small and there is little evidence that insulated walls with a fair-faced outer leaf have a higher incidence of frost damage or sulfate attack than uninsulated walls. However, walls painted with a vapour-resistant finish are more susceptible to frost and sulfate attack and the presence of full fill cavity insulation may increase the rate at which the render deteriorates.

3.2(a) For all walls, use masonry with sufficient frost resistance for the degree of exposure to wind-driven rain and freezing temperatures. Frost-resistant clay bricks should be specified for exposure zone 4 sites which are over 90 m above sea level and receive, on average, over 60 days of frost annually.

3.2(b) Use a sulfate-resisting cement in the base coat of the render and the brickwork mortar (*see BS 5628:Part 3:Table 13*) when rendering walls in exposure zones 4 and 3 onto clay bricks that have a soluble salt designation N (Normal as determined in BS 3921).

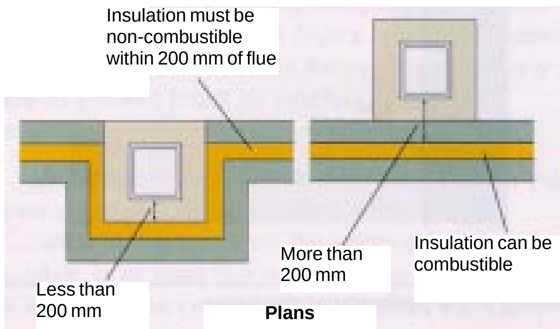
3.2(c) Use only vapour permeable paint finishes on facing masonry and render, since impermeable finishes can prevent the wall drying out and increase the risk of frost damage and sulfate attack. The combination of a painted finish and cavity insulation can significantly increase the risk of frost damage.

3.3 Condensation at thermal bridges

If a dense masonry element or an uninsulated component breaks the continuity of the wall insulation, the internal surface temperature may fall below the dew point, resulting in condensation and mould growth.

3.3(a) Avoid using recessed wall meter boxes or ensure insulation is continued behind the meter boxes.

3.3(b) Insulate around or across masonry chimneys ensuring that no combustible insulation is closer than 200 mm to the flue (Figure 35).



See 3.3(b)

Figure 35 Avoiding a thermal bridge at masonry chimneys

3.4 Condensation within the construction

Condensation can cause damage if it forms on the inner surface of unventilated impervious cladding or if water vapour is restricted from passing through the construction by a vapour-resistant layer on the cold side of the insulation.

3.4(a) Ventilate behind any impervious cladding. Drainage to the outside may have to be provided in cases of high risk.

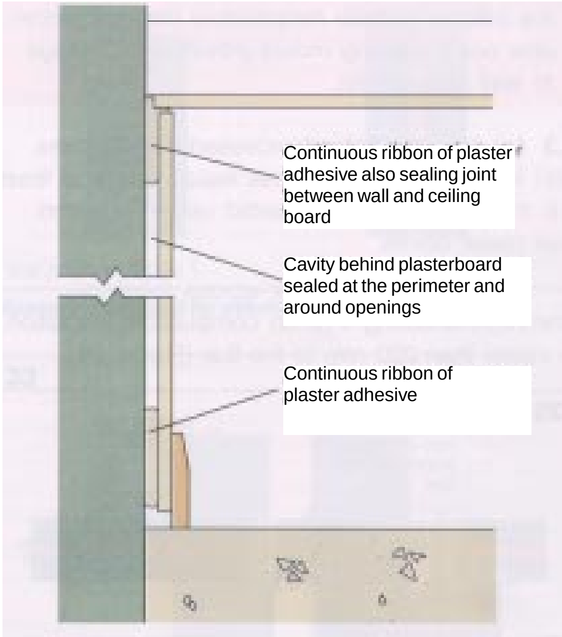
3.4(b) Ensure aluminium foil or polyethylene, on partial cavity insulation, is positioned on the warm, inner face of the insulation. Where this cannot be achieved the membrane should be perforated on the side facing the cavity to avoid condensation on the back of the membrane.

3.5 Increased heat loss due to air movement

Heat loss is increased if cold air from the cavity is able to move behind partial fill insulation or through an air permeable inner leaf to the interior via holes for services or gaps around dry lining.

3.5(a) Ensure that partial cavity insulation is held tightly against the inner leaf to avoid the movement of cold air behind the insulation and that joints between individual boards abut tightly. Consider sealing of the joints between insulation boards.

3.5(b) Seal the perimeter of the air space behind dry lining on external masonry walls by applying a continuous ribbon of plaster adhesive (not separate plaster dabs) at the ceiling, skirting, adjoining walls, window reveals and around holes made in the lining for services (Figure 36). Where necessary, consider introducing an airtightness or vapour permeable membrane within the construction to reduce air movement.



See 3.5(b), 3.8(a)

Figure 36 Sealing at the perimeter of dry lining

3.6 Spread of fire gases in the wall cavity

Smoke and fire gases can spread into the roof from the wall cavity.

3.6(a) Provide a cavity barrier at the top of unfilled cavities or cavities partially filled with insulation.

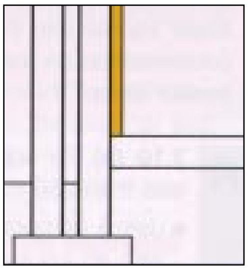
3.6(b) Cavities fully filled with non-combustible insulation do not need a cavity barrier at the top. A cavity closer is useful to contain injected cavity wall insulation.

3.7 Cracking of plaster due to shrinkage of lightweight blockwork

Lightweight concrete blocks shrink as they dry. If the blockwork is wet when plaster is applied, the subsequent shrinkage of the blocks can cause the plaster to crack.

3.7(a) Minimise visible cracking by:
- using a system of dry lining instead of plaster, *or*
- waiting for blockwork to dry out fully before applying plaster and, if necessary, providing shrinkage control joints as specified by the block manufacturer and in accordance with relevant standards.

Masonry walls with internal insulation



Characteristics of the construction

Insulation is applied to the internal surface of masonry walls and finished usually with plasterboard.

Insulation which can be of mineral wool or a plastics material is usually bonded to the plasterboard finish as a composite board, but it can also be built up in layers with a vapour control layer between the insulation and the plasterboard lining. For new build, it may need to be used in conjunction with lightweight blockwork and/or cavity insulation to achieve the required U-value.

R This insulation method provides an energy efficient alternative to wet plaster when the internal surface of a complete external wall is to be renewed.

Associated technical risks

3.8 Increased heat loss due to air movement
3.9 Condensation within the construction
3.10 Summer condensation on the vapour control layer
3.11 Fire spread due to combustible insulation
3.12 Spread of fire gases in the cavity behind insulated linings
3.13 Condensation at thermal bridges
3.14 Risks associated with electrics

Note: *For guidance on avoiding rain penetration, refer to section 3.1. Thermal bridging at the junctions of walls with other elements is covered in the appropriate sections on Roofs, Windows and Floors.*

Risks and avoiding actions

3.8 Increased heat loss due to air movement

Cold air moving through the masonry and then around or through holes in the insulated lining will cause an increase in heat loss.

3.8(a) Seal the perimeter of air spaces behind insulated linings. In the case of insulating plasterboard, use continuous ribbons of plaster adhesive, as for plasterboard lining (see *3.5(b)* and Figure 36 on page 31).

3.8(b) Seal any holes made in the insulated lining for services.

3.9 Condensation within the construction

Condensation can reduce the thermal performance of the building fabric and can cause damage within the construction if water vapour is unable to permeate through the wall or if moisture-laden air reaches the cold surface of the masonry.

R **3.9(a)** Provide a means of removing water vapour close to its source, eg install passive stack or mechanical extract ventilation in kitchens and bathrooms.

3.9(b) Incorporate a vapour control layer on the warm side of the insulation by:

- using an insulating plasterboard with an integral vapour control layer, *or*
- providing a separate vapour control layer, eg 500 gauge (0.12 mm) polyethylene, or a plasterboard lining with an integral vapour control layer when insulation is between timber battens. Timber in contact with the masonry should be preservative treated.

3.9(c) Ensure that separate vapour control layers are continuous and lining boards with an integral vapour control layer are close butting. Ensure that all joints are sealed.

3.9(d) Avoid puncturing the vapour control layer, by running services away from external walls whenever possible.

3.9(e) Seal any gaps cut in the vapour control layer to prevent moist air reaching the cold masonry.

3.9(f) The risk of condensation within the construction will be reduced if the vapour resistance of the layers on the warm side of the insulation is greater than that of the layers on the cold side. If this is not the case, for example due to the use of cladding with a high vapour resistance, assess the condensation risk using the calculation method in BS 5250.

3.10 Summer condensation on the vapour control layer

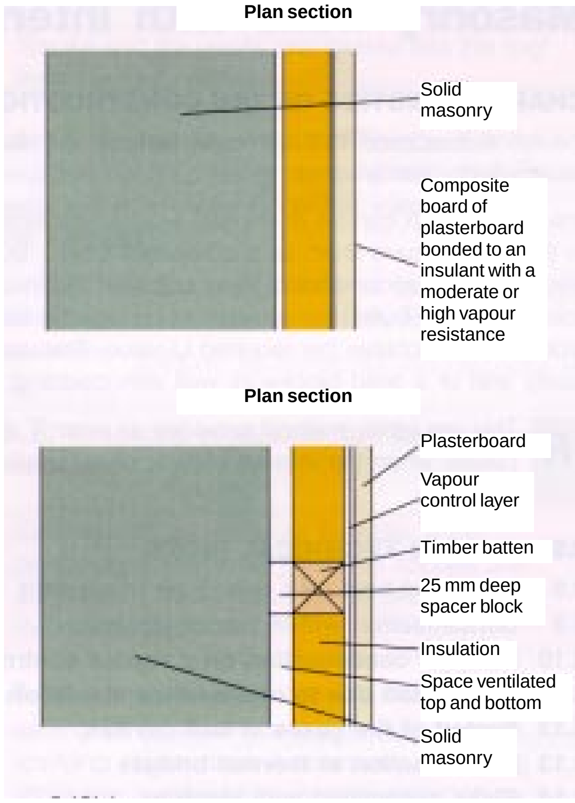
There is a risk of condensation forming on the vapour control layer in solid masonry walls, orientated from ESE through South to WSW, lined internally with a vapour permeable insulation. Sunshine radiating onto damp masonry can drive water vapour into the construction, causing condensation on the outside of the vapour control layer.

R

3.10(a) In the refurbishment of solid walls of facing masonry less than 250 mm thick, either:
- use a composite plasterboard laminate with an insulant of moderate or high vapour resistance, *or*
- add 25 mm deep spacer blocks behind the timber battens where the internal insulation is built up in layers. Ventilate the space behind the insulation to the outside at top and bottom by means of openings through the masonry 750 mm^2 in area at 1.2 m centres. To avoid increased heat loss, through air movement, ensure that the insulation is tight-fitting between the timber battens and seal the plasterboard lining at the top, bottom, all corners and at penetrations (Figure 37).

3.10(b) For new-build walls of solid masonry:
- use a rendered finish and adopt one of the internal insulation methods given in 3.10(a), *or*
- protect the masonry with a ventilated cladding (such as tile hanging or timber boarding) or with an outer masonry leaf with a clear cavity.

3.10(c) Do not paint facing or rendered masonry with decorative finishes that are impermeable to water vapour.



See 3.10(a)

Figure 37 Internal insulation on solid walls

3.11 Fire spread due to combustible insulation

Where combustible insulation is added to the internal face of a wall, it presents a fire hazard and should be protected by materials that can restrict its contribution to a fire.

3.11(a) Protect combustible internal insulation with a facing material that can prevent fire involvement of the insulation, eg 12.5 mm plasterboard.

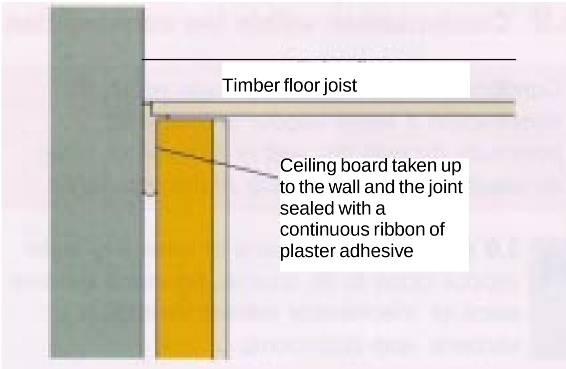
3.11(b) Fix the facing material mechanically to the masonry to prevent premature collapse in a fire, follow the recommendations of the insulation manufacturer.

3.12 Spread of fire gases in the cavity behind insulated linings

Smoke and fire gases can spread to other elements through cavities behind insulated linings.

3.12(a) Seal the junctions of insulating plasterboard laminates with floors, ceilings and adjoining walls using timber battens or continuous ribbons of plaster.

3.12(b) Ensure that the ceiling plasterboard extends to the masonry wall and seal the joint with plaster adhesive (Figure 38).



See 3.12(b)

Figure 38 Sealing insulating plasterboard at the ceiling

3.13 Condensation at thermal bridges

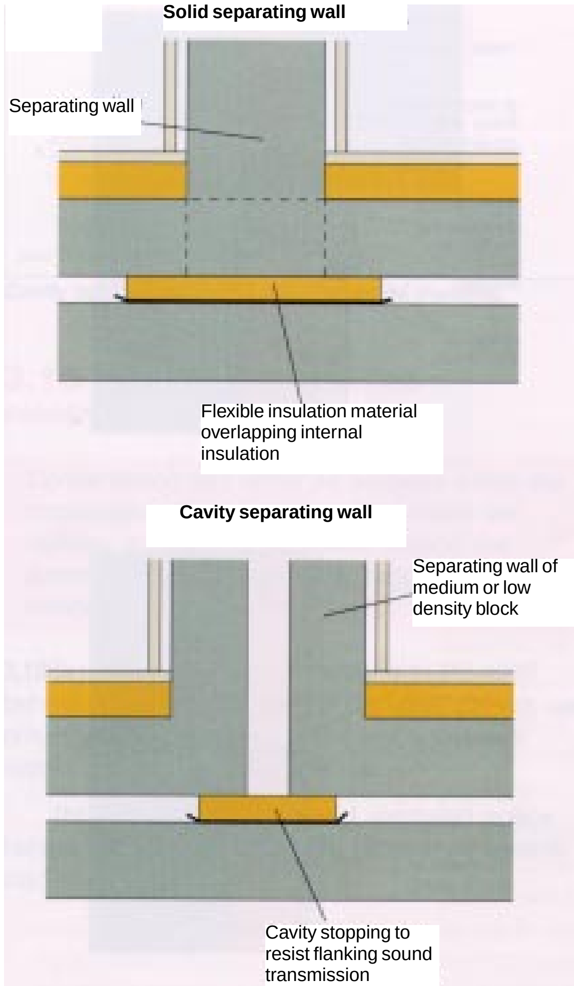
At junctions with separating walls and internal partitions, the continuity of internal insulation is broken, creating a potential thermal bridge.

3.13(a) For solid external walls, or for the inner leaf of cavity walls, use masonry with the lowest possible density compatible with requirements for structural stability and flanking sound transmission.

Separating wall junctions

3.13(b) Avoid a thermal bridge at separating walls by:

- filling the external wall cavity with a strip of insulation so that it overlaps the internal insulation either side of the separating wall (this should be a flexible material such as mineral wool when required to restrict flanking sound transmission), *or*
- choosing a separating wall specification which allows a medium or low density block to be used, *or*
- lining the separating wall with plasterboard insulated with mineral wool, subject to sound insulation requirements (Figure 39).



See 3.13(b)

Figure 39 Junctions with separating walls

Partition junctions

3.13(c) Avoid a thermal bridge at partitions by:

- using low density blockwork for partitions and for the external wall, *or*
- taking the internal insulation fully across the external wall and constructing a timber stud partition inside this insulation.

R **3.13(d)** Use low density blockwork for any new masonry partitions; tie to the external wall and finish with dry lining.

3.14 Risks associated with electrics

Electrical cables give off heat when in use. Where cables are covered by thermal insulation they may overheat, increasing the risk of short circuit or fire.

PVC sheathing to cables can have reduced life expectancy if in direct contact with expanded polystyrene insulants.

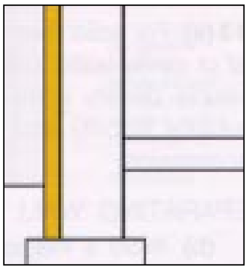
Unprotected cables can be punctured by nails if close to the wall surface.

3.14(a) Route cables where they will not be covered by insulation so that they can dissipate heat. If this is not possible, the cables may need to be increased in size, even when in conduit, especially where they serve cooker points and high output heaters (*see Appendix A*).

3.14(b) Locate PVC-insulated cables in conduit or away from direct contact with expanded polystyrene insulation.

3.14(c) To avoid mechanical damage, specify metal conduit if the cable is within 50 mm of the plasterboard lining.

Masonry walls with external insulation



Characteristics of the construction

Insulation is applied to the external surface of masonry walls and finished with cladding, render, proprietary surface coating, or tile hanging.

R This insulation method is appropriate for upgrading existing buildings when:
- the cavity is unsuitable for filling and internal insulation is not a viable option,
- facing masonry is likely to deteriorate if left unprotected,
- renewal of a rendered finish or cladding is being considered,
- solid walls are to be insulated.

Associated technical risks

Note: *For guidance on avoiding rain penetration, refer to section 3.1. Thermal bridging at the junctions of walls with other elements is covered in the appropriate sections on Roofs, Windows and Floors.*

Risks and avoiding actions

3.15 Impact damage and cracking of render

Rendering on insulation is more vulnerable to impact damage and is subject to greater fluctuations in temperature than when applied directly to masonry.

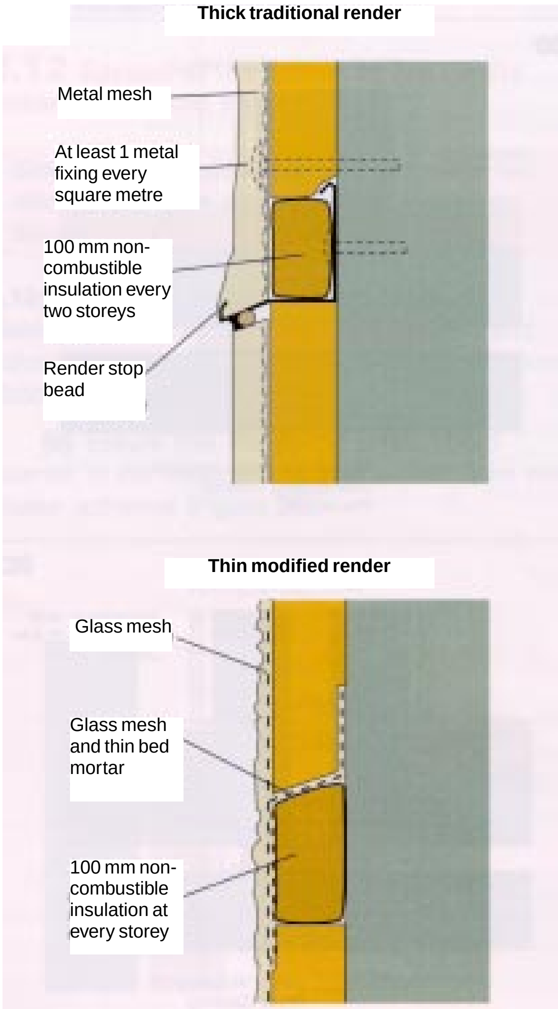
3.15(a) Take precautions to minimise cracking by:
- reinforcing the render with a mesh,
- providing movement joints compatible with the system,
- using a light-coloured finish,
- using a render incorporating a polymer and/or fibres.

3.16 Fire propagation due to combustible insulation

Where combustible insulation is applied to the external face of a wall it can present a fire hazard unless protected.

3.16(a) Protect combustible insulation boards with a render that will prevent active fire involvement of the insulant and fire propagation.

3.16(b) Reinforce the render with mesh, mechanically fixed through the insulation to the masonry wall using non-combustible fixings, to prevent premature collapse of the render and incorporate non-combustible cavity barriers across the insulation to comply with building regulations (Figure 40).



See 3.16(b)

Figure 40 Rendered external insulation system

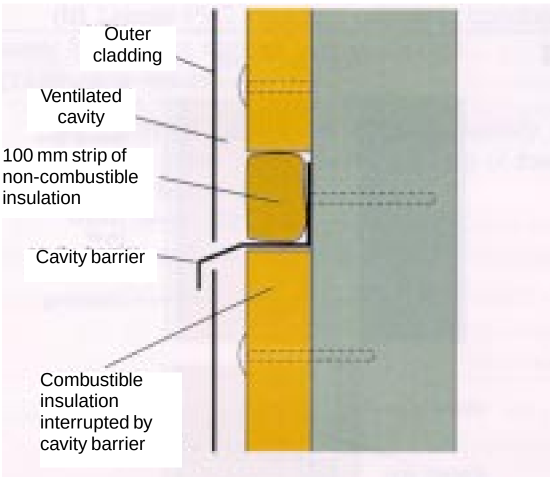
3.17 Spread of fire in wall cavities

Smoke and fire gases can spread through cavities in the construction, particularly between the insulation and cladding.

3.17(a) Install a cavity barrier at the head of each cavity formed by the overcladding (Figure 41).

3.17(b) Install cavity barriers between cladding and the structural wall at compartment walls and floors, and at each floor level of residential buildings as required by building regulations (Figure 41).

3.17(c) Ventilate the cavity behind impermeable cladding. This will require ventilation openings at the top and bottom of each void enclosed by cavity barriers (Figure 41).



See 3.17(a), (b), (c)

Figure 41 Cavity barriers with ventilated insulated cladding

3.18 Condensation within the construction

Condensation can occur on surfaces within the construction if water vapour from inside the building is unable to permeate through the external insulation system or be ventilated safely away.

3.18(a) Use a vapour permeable membrane, where required, behind tile hanging or similar cladding. Do not use polyethylene or bitumen loaded building paper since they will restrict the passage of water vapour.

3.18(b) Provide a drained and ventilated space behind PVC-U, metal sheet or other impermeable cladding.

3.19 Delamination of composite profiled sheet cladding panels

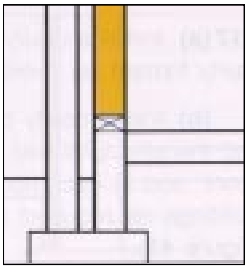
Where fully filled panels, which rely on full bonding of the insulation to the outer and inner sheets, are subjected to extreme structural or thermal stresses the result can be cracking or delamination of the insulation. This can lead to bowing and may have durability implications for the system.

3.19(a) Seek guidance and assurance from the manufacturer that the intended structural loading can be adequately carried by the system.

3.19(b) Design within recommended span limits for wind loading.

3.19(c) Choose light rather than dark colours for external finishes, whenever possible, to minimise the risk of thermal bowing.

Walls of timber-framed construction



Characteristics of the construction

The insulation is usually placed within the thickness of the timber-framed structure between the outer sheathing and the inner lining. With increased levels of insulation this may be supplemented by an additional internal lining of thermal insulation or insulated sheathing to reduce the heat loss through the timber studs.

R This construction method is appropriate for extensions.

Associated technical risks

3.20 Condensation within the construction
3.21 Risks associated with electrics

Note: *For guidance on avoiding rain penetration, refer to section 3.1. Thermal bridging at the junctions of walls with other elements is covered in the appropriate sections on Roofs, Windows and Floors.*

Risks and avoiding actions

3.20 Condensation within the construction

If water vapour from inside the building is allowed to pass through the insulation to the cold part of the structure, it may condense. If this occurs for extended periods, the timber structure may be at risk of decay.

3.20(a) Incorporate a vapour control layer on the inside face of the timber studs by:

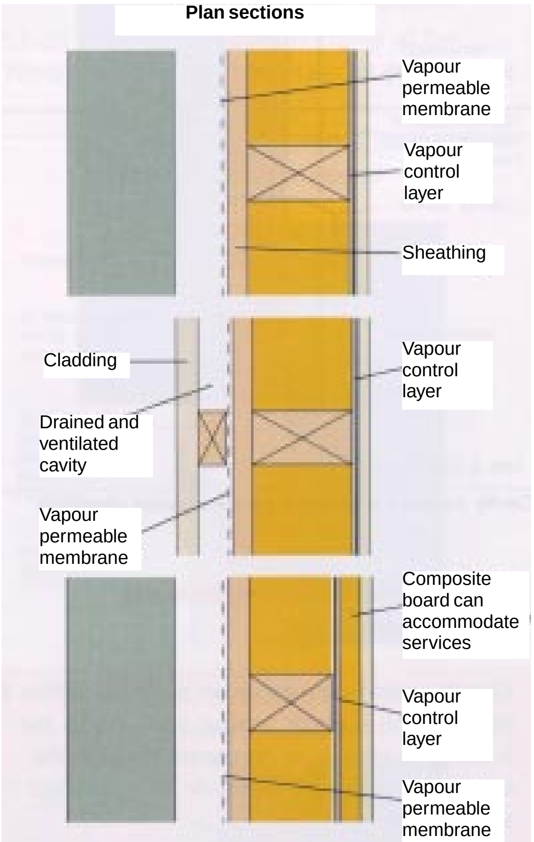
- providing a separate vapour control layer, eg 500 gauge (0.12 mm) polyethylene behind the plasterboard lining, *or*
- using a plasterboard lining with an integral vapour control layer (Figure 42).

3.20(b) Ensure that the separate vapour control layer is continuous and joints are sealed, or that lining boards with an integral vapour control layer are close butting over framing supports (Figure 42).

3.20(c) Avoid running services in external walls whenever possible to reduce the risk of puncturing the vapour control layer.

3.20(d) When it is not possible to avoid services in the external wall:

- ensure neat cutting of the separate vapour control layer, or plasterboard linings with an integral vapour control layer, around services and seal any gaps, *or*
- route service runs within the insulation of a composite plasterboard laminate on the warm side of the vapour control layer (Figure 42).



See 3.20(a), (b), (d), (f)

Figure 42 Typical timber-frame construction methods

3.20(e) When insulation is introduced on the warm side of the vapour control layer, ensure that the thermal resistance of the construction on the cold side of the vapour control layer is greater than the resistance of the construction on the warm side.

3.20(f) Ensure that a clear cavity is maintained behind the cladding and that it is drained and ventilated (Figure 42).

3.20(g) The risk of condensation will be reduced if the combined vapour resistance of the layers on the warm side of the insulation is greater than that of the layers on the cold side. If this is not the case, for example due to the use of cladding or sheathing with a high vapour resistance, assess the condensation risk using the calculation method in BS 5250.

3.21 Risks associated with electrics

Electrical cables give off heat when in use. Where cables are covered by thermal insulation they may overheat, increasing the risk of short circuit or fire.

PVC sheathing to cables can have reduced life expectancy if in direct contact with expanded polystyrene insulants.

Unprotected cables can be punctured by nails if close to the wall surface.

3.21(a) Route cables where they will not be covered by insulation so that they can dissipate heat. If this is not possible, the cables may need to be increased in size, even when in conduit. The circuits most likely to be affected are those serving cookers, immersion heaters, shower units, socket outlets and high wattage heaters (see *Appendix A*).

3.21(b) Locate PVC-insulated cables in conduit or away from direct contact with expanded polystyrene insulation.

3.21(c) To avoid mechanical damage, specify metal conduit if the cable is within 50 mm of the plasterboard lining.

Quality control checks for walls

Masonry cavity walls

- Is the wall specification, including the cavity width and the thickness and type of insulation, suitable for the wall exposure?
- Is the specification of the masonry units, mortar and any finishes appropriate in respect of frost and sulfate resistance?
- Is the cavity width within specified limits?
- Are all mortar joints, particularly perpends, filled, and are all weepholes clear?
- Is the cavity free of mortar droppings and other debris?
- Are all dpcs, cavity trays and stop ends as specified?
- *For built-in cavity fill:*
  - — have third-party certificate and manufacturers' installation procedures been followed?
  - — is the insulation tightly butted and are off-cuts correctly aligned?
  - — have mortar droppings been removed from exposed edges of insulation?
  - — is partial fill insulation held tightly against the inner leaf?
- *For injected cavity fill:*
  - — has the third-party approved installer accepted the wall as suitable for filling?
  - — is installation in accordance with relevant standards or third-party certification and associated surveillance schemes?
  - — has insulation been included to reduce thermal bridging at meter boxes and chimneys?

Masonry walls with internal insulation

- Is the wall specification including the masonry type and thickness suitable for the wall exposure?
- Is the specification of the masonry units, mortar and any finishes appropriate in respect of frost and sulfate resistance?
- Do continuous ribbons of plaster seal the space behind insulated plasterboard linings at the perimeter of walls and openings, and around holes in plasterboard?
- Is a continuous vapour control layer with lapped and taped joints fitted behind plasterboard linings, or is it incorporated in a composite board?
- Are external paint finishes permeable and is ventilation provided behind any external cladding?
- Is ventilation provided behind masonry where recommended and specified?
- Has insulation been included to reduce thermal bridging at wall and partition junctions?
- Are adhesive-fixed composite boards stabilised by mechanical fixings?
- Is contact avoided between PVC-insulated cables and polystyrene and are electric cables rated correctly where in contact with any insulation?

Masonry walls with external insulation

- Is the cladding system suitable for the wall exposure?
- Has the external insulation system been applied in accordance with third-party certification by approved installers?
- Are fire barriers installed correctly at the recommended locations?
- Is there effective ventilation and drainage behind ventilated overcladding, particularly around fire barriers?
- Is the membrane behind tile hanging or similar cladding of a vapour permeable type?

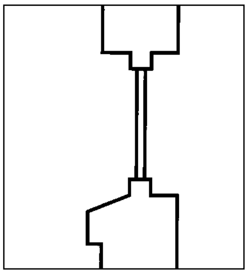
Walls of timber-framed construction

- Are the cladding and the clear cavity width suitable for the wall exposure?
- Is the vapour control layer continuous and neatly cut and sealed where services penetrate it?
- Does insulation fully fill the spaces between the timbers?
- Are cables rated correctly when in contact with insulation and are they protected from piercing by fixings?
- Is the cavity free of mortar droppings and other debris?
- Are all dpcs, cavity trays and stop ends as specified?
- Is the space behind cladding drained and ventilated?

4

Windows

Window to wall junctions



Characteristics of the construction

This sub-section covers the technical risks which can occur where window or external door frames meet the surrounding masonry wall.

R This guidance is appropriate when replacement windows are installed in an existing structural opening or when the internal plaster finish of the external wall is to be replaced with internal insulation.

Associated technical risks

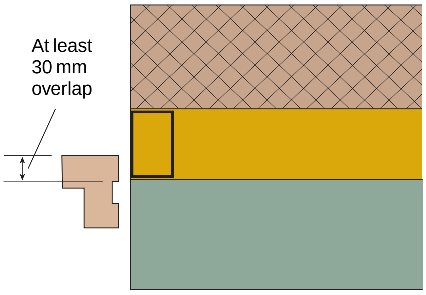
4.1 Condensation and mould at thermal bridges
4.2 Increased heat loss due to air movement
4.3 Mould on reveals due to contact with thermally conductive window frames

Risks and avoiding actions

4.l Condensation and mould at thermal bridges

If a dense part of the construction interrupts the continuity of the insulating layer, the internal surface temperature may fall locally below the dewpoint, resulting in condensation, causing mould growth and damage to wall decorations.

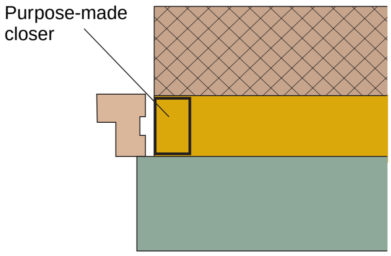
4.1(a) When a window or door frame is set back behind the inner face of a dense outer masonry leaf, it should overlap an insulated closer by a minimum of 30 mm (Figure 43).



See 4.1(a)

Figure 43 Window frame overlapping an insulated closer

4.1(b) Set the frame back its full width in a rebated or checked reveal in very severe exposure zones (zone 4) (Figure 44).

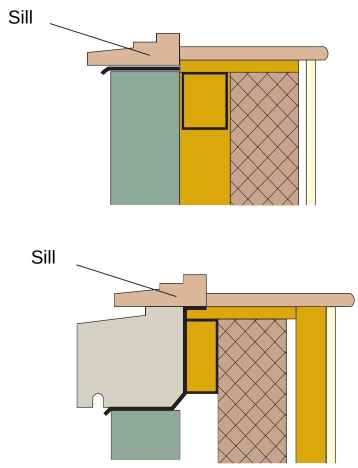


See 4.1(b)

Figure 44 Window frame in very severe exposure category

4.1(c) Ensure that the wall construction has a minimum resistance of 0.45 m^{2}k/W through an air-filled cavity closer.

4.1(d) Close the cavity with an insulated closer or apply insulation beneath the window board to achieve a minimum thermal resistance of 0.45 m^2 k/W (Figure 45).



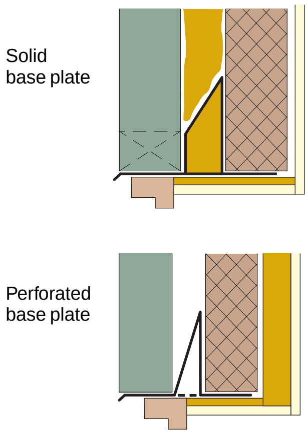
See 4.1(d)

Figure 45 Insulation to sills

4.1(e) Where practical, specify an independent lintel arrangement over openings, otherwise:

- insulate the lintel to provide a minimum resistance of 0.34 m^{2}K/W where the lintel is constructed with a solid base plate, *or*
- specify a lintel with a perforated base plate which has a maximum effective thermal conductivity of 30 W/mK (Figure 46).

Ensure that, where installed, full or partial cavity fill is cut or shaped to fit fully against the lintel.



See 4.1(e)

Figure 46 Insulation to lintels

4.1(f) Consider whether the position of trickle ventilators in the frame is affected by the presence of an insulated soffit lining.

R **4.1(g)** Follow the appropriate guidance given in *4.1(a) to (f)* when replacing windows or substituting insulating plasterboard for plaster as an internal wall finish.

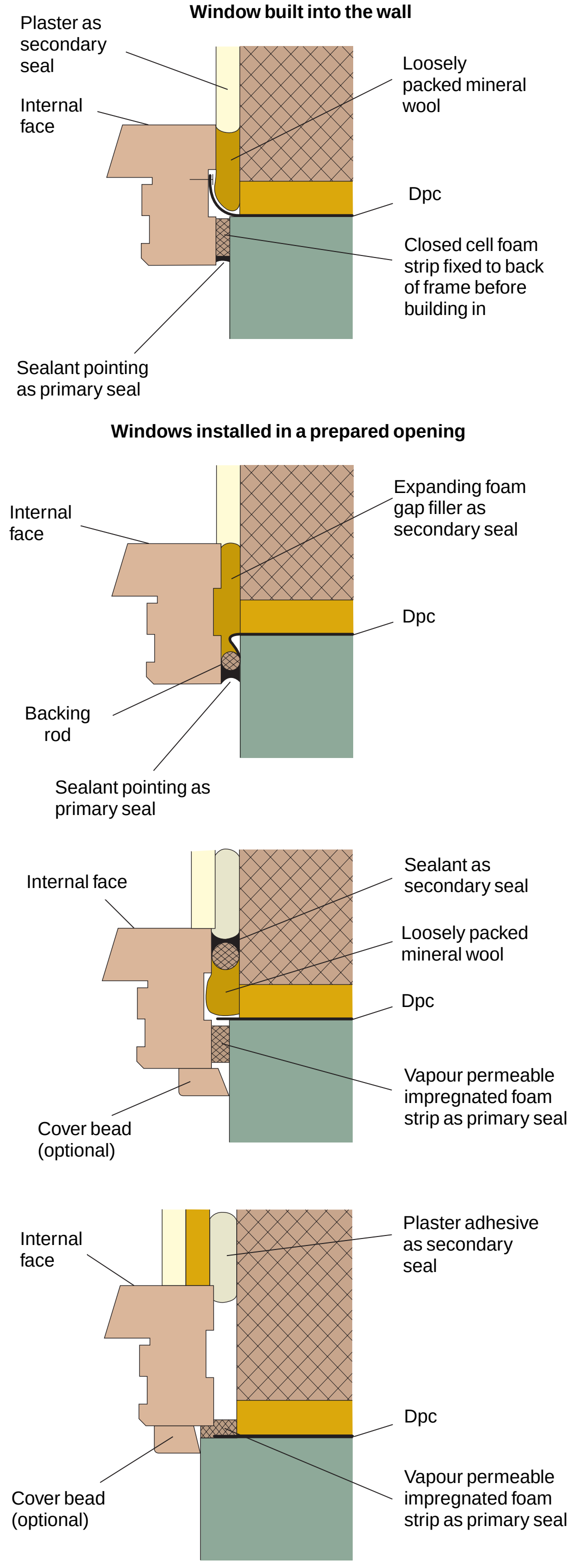
4.1(h) Fill as much as possible of the space between the frame and the wall with insulation such as expanding foam or mineral wool (Figure 47).

4.2 Increased heat loss due to air movement

Failure to make an airtight seal between the window frame and the walling can result in unacceptable draughts and unnecessary heat loss.

4.2 (a) Seal the joint between the frame and the wall with an outer primary seal and an inner secondary seal using:

- sealant pointing on the outside and expanding foam or plaster on the inside, *or*
- impregnated foam strip on the outside and sealant pointing on the inside, *or*
- sealant bedding on the outside and plaster adhesive on the inside (Figure 47).



See 4.1(h), 4.2(a), (b)

Figure 47 Examples of sealing at window to wall junctions

4.2(b) Allow sufficient tolerance in building openings to allow for window installation, making the seals and filling the space between the frame and the wall with insulation (Figure 47).

It is preferable to build the opening in the inner masonry leaf wider than that in the outer leaf to create sufficient space to insert insulation into the joint and make an effective secondary seal.

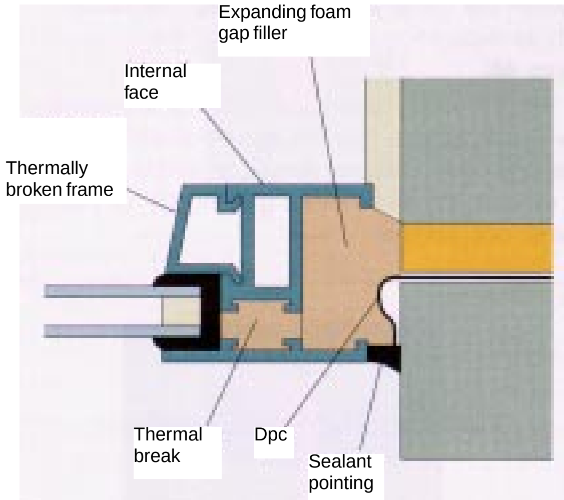
4.3 Mould on reveals due to contact with thermally conductive window frames

Windows having thermally conductive frames can suffer badly from condensation and, if they abut absorbent finishes such as plaster, can be the cause of mould growth at window reveals.

4.3(a) For preference, select windows and frames which incorporate thermal breaks (Figure 48).

4.3(b) For windows without thermal breaks:

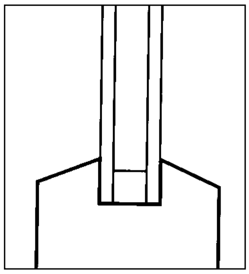
- install the window in a durable low conductivity sub-frame and incorporate a channel to collect temporarily any condensation run-off from the window frame, *or*
- fill the space between the frame and the wall with expanding polyurethane foam (Figure 48).



See 4.3(a), (b)

Figure 48 Thermally broken window frame with foam sealing to wall

Insulated glazing



Characteristics of the construction

Insulated glazing, and in particular double glazing, is specified as standard for windows, rooflights and glazed external doors. Increasingly these units are filled with an inert gas and the inner faces of the glass treated with low emissivity coatings. Multiple layers of glazing, eg triple glazed units, are being used.

R Insulated glazing may be provided when replacing existing single-glazed windows.

Associated technical risks

4.4 Failure of edge seals in glazing units
4.5 Deformation of window frames

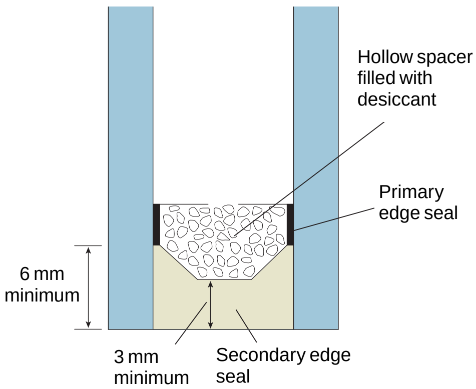
Risks and avoiding actions

4.4 Failure of edge seals in glazing units

The edge seals of glazing units will deteriorate if they are exposed to sunlight or if water is trapped against the edge seal for prolonged periods. This deterioration results in condensation within the unit. There may also be incompatibility between the glazing compound and the edge seal material or decorative finish that can lead to failure of the edge seal. Quality control during manufacture is important and can dictate the lifetime of the unit that is likely to be achieved.

4.4(a) Select a window that is properly glazed in the factory. Fully bedded timber windows should always be factory glazed.

Insulated glazing units
4.4(b) Use sealed units tested to the relevant standard and ensure that they have third-party certification (Figure 49).



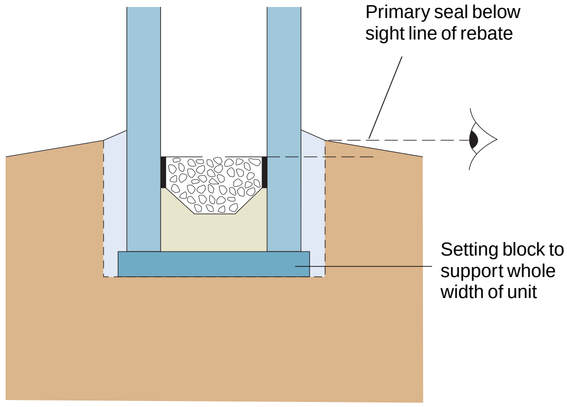
See 4.4(b)

Figure 49 Glazing unit with dual seal

4.4(c) Check with the manufacturer of the sealed units that the material for the edge seal is compatible with the proposed glazing compounds and any coating applied to the glazing.

4.4(d) Protect the edge seal from sunlight by ensuring that the rebate is of sufficient depth for the edge seal of the insulated glazing unit to be below the sight line and spacer bar of the rebate upstand and the glazing bead (Figure 50, 52 and 53).

4.4(e) Ensure gas filled units are tested to the appropriate test standard, are CE marked and have third party certification.



See 4.4(d)

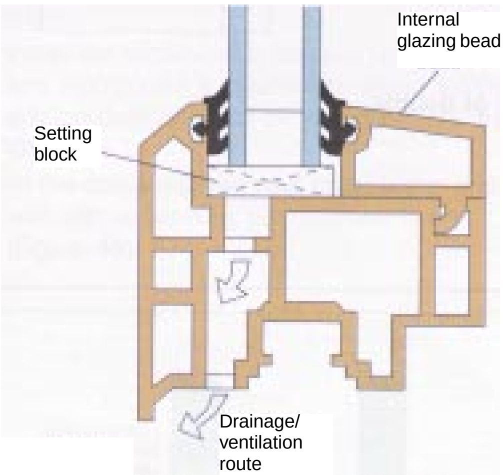
Figure 50 Edge seal protected from sunlight

Glazing methods

4.4(f) Avoid methods that rely on a complex installation procedure or frequent maintenance to prevent premature failure of the edge seal. Glazing techniques for insulating glass units by the Glass and Glazing Federation, BS 8000: Part 7 and BRE Digest 453 give more detailed advice on preferred glazing methods.

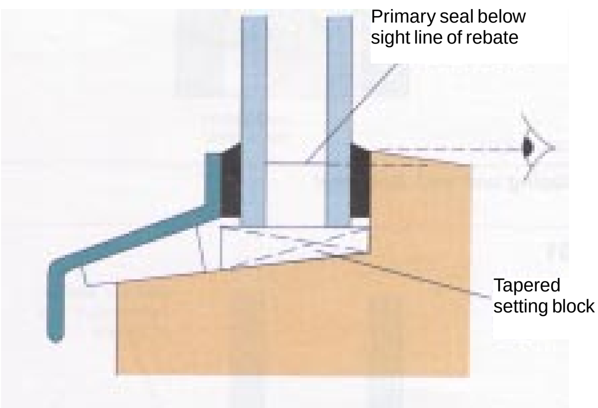
4.4(g) Use a drained and/or ventilated glazing method whenever possible for PVC-U, aluminium, steel and timber windows (Figures 51 and 52).

4.4(h) Use a fully bedded method for timber and steel windows only when a drained and/or ventilated method is not suitable. Specify that there should be no voids within or between the glazing materials (Figure 53). Do not use linseed oil putty or butyl compounds for fully bedded systems.



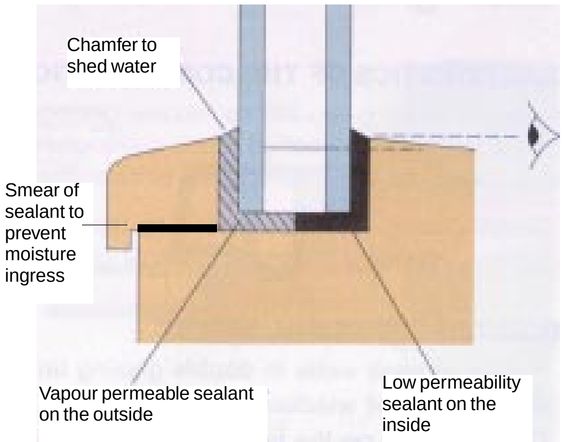
See 4.4(g)

Figure 51 PVC-U frame with drained and ventilated glazing method



See 4.4(d), (g)

Figure 52 Timber frame with drained and ventilated glazing method



See 4.4(d), (h), (i)

Figure 53 Timber frame with fully bedded sealing method

4.4(i) Ensure that water is shed away from the glass surface by:

- tooling the sealant or sealant capping to a smooth chamfer, *or*
- trimming strip sealants to give a sloping top edge (Figure 53).

4.4(j) Ensure that the glazing compounds are compatible with the decorative finish for the window. Do not use linseed oil based putty.

4.4(k) Provide support and restraint for the double glazing units within the frame by using:

- setting blocks of appropriate dimensions on the horizontal glazing platform,
- location blocks in vertical and top rebates to prevent movement of the unit in the frame when windows are open or closed, positioned according to the hinge arrangement,
- distance pieces at least 3 mm thick where necessary to prevent displacement of the glazing compound due to wind pressure on the glass. Distance pieces should be opposite each other on both sides of the unit. They are not necessary when using load-bearing strip compounds.

4.4(l) Ensure that the frame rebate is of sufficient size to allow for:

- clearance around the unit to accommodate setting and location blocks,
- tolerance in the size of the insulated glazing unit.

4.5 Deformation of window frames

Some lightweight window frames are not robust enough for the extra weight of insulated glazing units. Frames may deflect repeatedly under wind gusting, causing glazing units to crack or seals to be broken. Frames, especially of opening lights, may also distort if the glazing units are not properly supported or restrained by setting and location blocks.

4.5(a) Use windows whose frames, hinges and opening mechanisms are designed to carry the weight of the specified double-glazing units. Do not exceed the frame manufacturers' recommended limits on sash weights and dimensions.

Quality control checks for windows

Window to wall junctions

- Does the window frame overlap insulating cavity closers and by the required amount to avoid condensation risk?
- Is the lintel insulated where it has a continuous base plate?
- Have trickle vents been located so as not to be affected by an insulated soffit lining?
- Are window/wall junctions insulated and is the joint sealed both externally and internally?

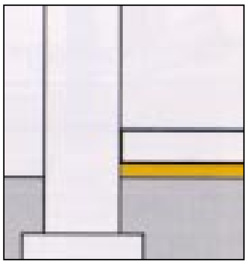
Insulated glazing units

- Are sealed units appropriately quality marked?
- Is the rebate upstand deep enough to protect the edge seal from sunlight when glazed?
- Are setting blocks, location blocks and distance pieces correctly installed?
- Are the internal windows of double windows sealed and is the space between the panes ventilated to the outside?
- Do the windows allow effective ventilation by natural means; or is it provided by other methods?

5

Floors

Concrete ground floors insulated below the structure



Characteristics of the construction

Insulation is usually laid horizontally below the whole area of the floor. Insulation should be rigid boards with a high moisture resistance and compressive strength and, if placed below the damp proof membrane (dpm), resistant to any contaminants present in the ground or fill material.

Concrete floors insulated in this way are cast in-situ and can be:

- fully supported on the ground or compacted fill (ie not built into the surrounding walls), *or*
- supported by the surrounding walls as reinforced suspended slabs (ie built into the walling).

The dpm may be placed above or below the concrete. If placed below the concrete, the dpm can be above or below the insulation. If above the concrete and the floor is located on landfill sites or on ground containing high levels of sulfates or radon, an additional membrane may be needed beneath the concrete to separate the concrete from these ground contaminants.

R These recommendations apply when replacement of an existing concrete floor or a timber suspended floor with one of in-situ concrete is proposed.

Associated technical risks

5.1 Reduced structural stability and thermal performance
5.2 Damage during construction
5.3 Condensation at thermal bridges
5.4 Damage from moisture in the floor
5.5 Risks associated with services

Note: In some instances, dpms and tanking have been omitted in the figures to the Floors section since there are several options for their location.

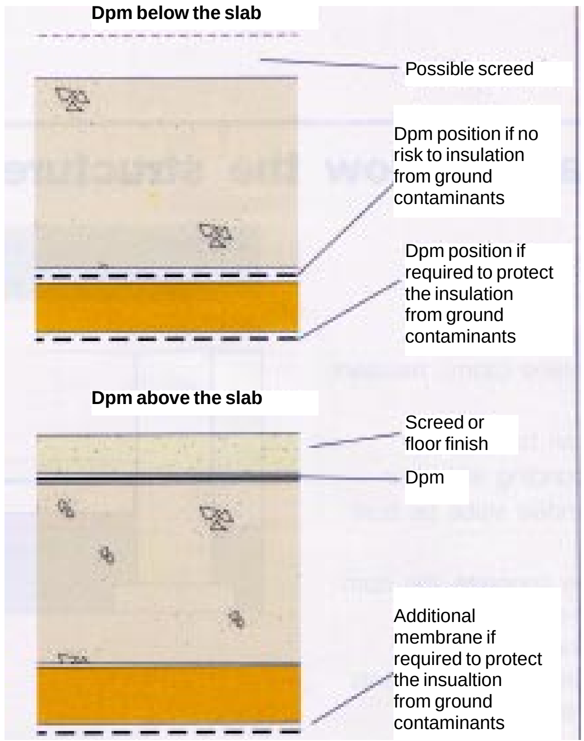
Risks and avoiding actions

5.1 Reduced structural stability and thermal performance

As ground supported slabs are cast directly onto the insulation, deformation of the insulation could lead to initial subsidence, unexpected stresses in the floor slab and a reduction in thermal performance. Deformation may be caused by compression from loading or degradation where insulants react chemically with contaminants present in the ground or fill.

5.1(a) To avoid degradation of the insulation:

- use a type with low water absorption and high resistance to any expected chemicals in the ground or fill, *or*
- place the insulation on a dpm or separating membrane (Figure 54).



See 5.1(a)

Figure 54 Alternative dpm positions

Ground supported slabs

5.1(b) Use an insulant with sufficient compressive strength to resist the weight of the slab, the anticipated floor loading as well as any possible overloading due to stored materials. Ensure that hardcore is well compacted and covered with sand blinding to provide even support for the insulation. Provide separate foundations for internal loadbearing walls.

Reinforced suspended slabs

5.1(c) Ensure that, where required, the insulation has sufficient compressive strength to act as shuttering during setting of the concrete floor slab.

5.2 Damage during construction

Unless care is taken when laying the floor, the dpm and the insulation materials can become displaced or damaged.

5.2(a) Lay the insulation boards and dpm (if below the slab) immediately before placing the concrete.

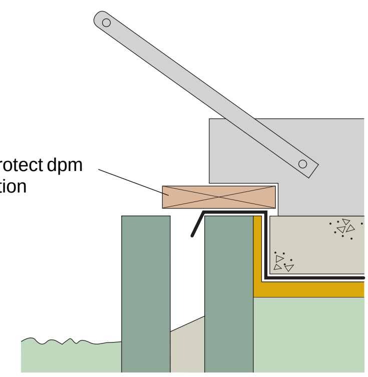
5.2(b) Consider laying the dpm above the slab if appropriate for, and compatible with, the floor finish.

5.2(c) Ensure that the insulation boards fit tightly together and are weighed down as necessary before and after laying the dpm.

5.2(d) Take extra care before and during laying concrete to prevent damaging the dpm with sharp objects.

Ground supported slabs

5.2(e) When tamping, protect the insulation and the dpm where they turn up vertically to meet the wall dpc, eg with a temporary timber board (Figure 55).

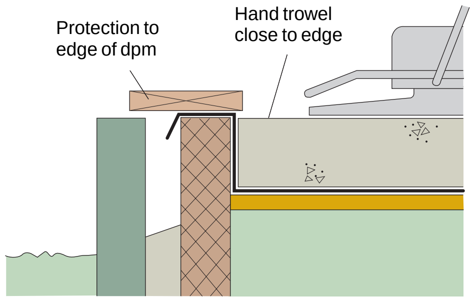


See 5.2(e)

Figure 55 Protection to dpm and insulation when tamping

5.2(f) To avoid damaging the dpm and insulation when power trowelling:

- protect the edge of the dpm and insulation with a board and hand trowel close to the edge of the floor (Figure 56), *or*
- lay the dpm above the slab (if compatible with the floor finish) later in the construction process.



See 5.2(f)

Figure 56 Precautions when power trowelling

Reinforced suspended slabs

5.2(g) Ensure a firm base for the dpm and insulation to avoid the membrane being torn where it meets the external wall.

5.2(h) Take care not to puncture the dpm when placing the reinforcement.

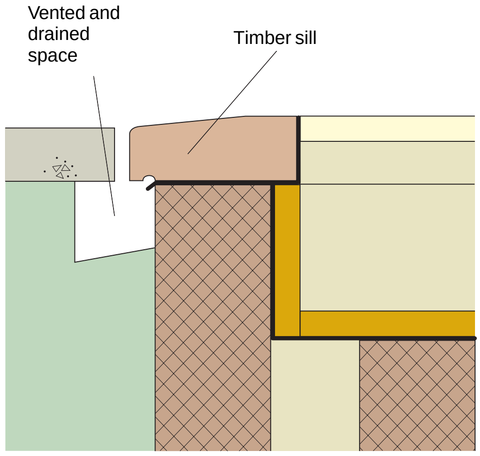
5.3 Condensation at thermal bridges

Where the continuity of the insulation is broken at junctions between the floor and external walls or loadbearing internal walls, a thermal bridge occurs and there is the risk of surface condensation.

5.3(a) Start cavity insulation below damp proof course (dpc) level, and preferably below, but at least to the same level as the base of the floor slab (Figures 58A and B).

5.3(b) Use low density blockwork for the inner leaf of a cavity wall below dpc if structurally acceptable and suitable for the ground conditions (Figure 58A).

5.3(c) Position the door frame within the reveal so that the threshold overlaps the wall insulation. Ensure the floor insulation is continuous with the wall insulation and extends below the threshold (Figure 57). Provide protection, in accordance with local exposure and ground conditions, to the threshold.



See 5.3(c)

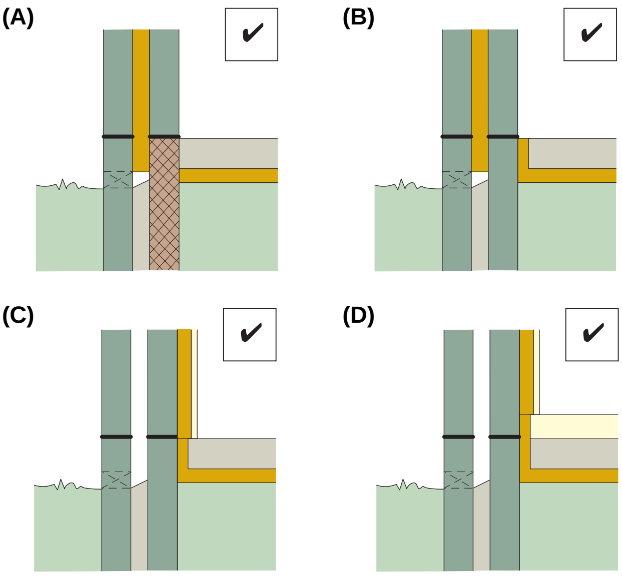
Figure 57 Avoiding thermal bridge at threshold

Ground supported slabs

5.3(d) Use a vertical strip of insulation at the perimeter of the slab:

- to provide a minimum 150 mm overlap with cavity insulation (Figure 58B), *or*
- to link with internal wall insulation (Figure 58C).

5.3(e) Use a strip of insulation at the perimeter of the screed to maintain continuity between the slab insulation and internal wall insulation (Figure 58D). Ensure that there is sufficient protection to the top of the perimeter insulation.

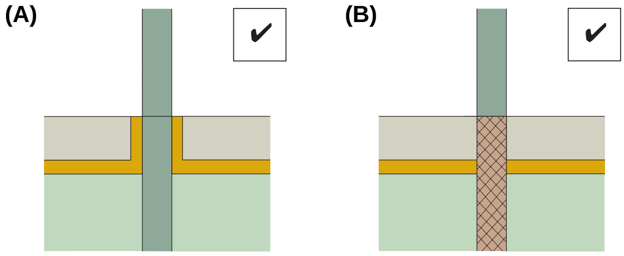


(A) See 5.3(a), (b); **(B)** See 5.3(a), (d); **(C)** See 5.3(d); **(D)** See 5.3(e)

Figure 58 Avoiding thermal bridges in ground supported slabs

5.3(f) For internal loadbearing walls:

- place a vertical strip of insulation against internal loadbearing walls for a distance of 1 metre from any junction with an external wall (Figure 59A), *or*
- use low density blockwork below dpc (Figure 59B).

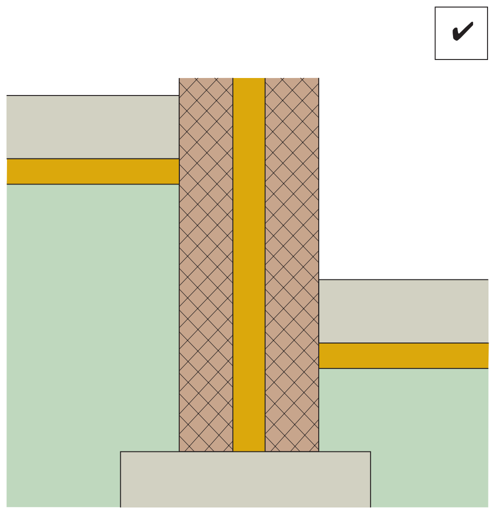


(A) See 5.3(f); **(B)** See 5.3(f)

Figure 59 Avoiding thermal bridges at internal loadbearing walls

5.3(g) For stepped separating walls:

- choose a sound insulation specification which allows the use of low density blockwork (subject also to structural requirements) (Figure 60), and consider insulating within the cavity from the higher of the two floors down to the foundation with resilient insulation suitable for that purpose.

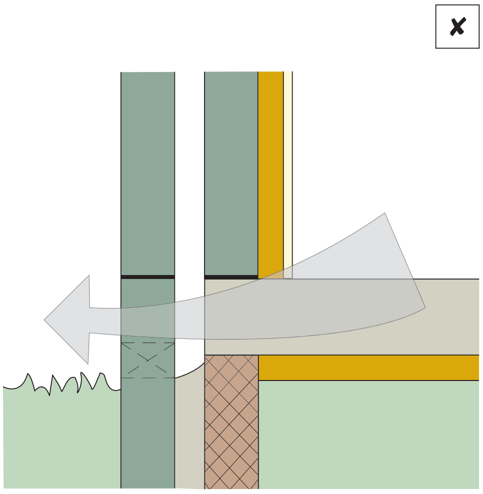


See 5.3(g), 5.3(j)

Figure 60 Avoiding thermal bridges at stepped separating walls

Reinforced suspended slabs

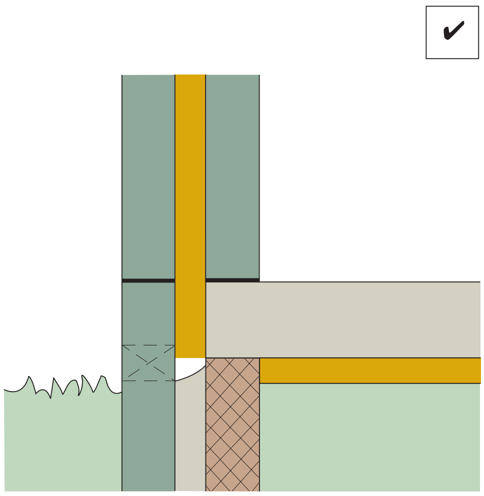
5.3(h) Avoid using suspended slabs, built into the external wall in conjunction with internal insulation since it is difficult to avoid a thermal bridge (Figure 61).



See 5.3(h)

Figure 61 Avoid using suspended slabs and internal insulation together

5.3(i) Use suspended slabs in conjunction with cavity insulation only if it is possible to support the floor on low density blockwork and to extend the cavity insulation below the level of the floor slab. Otherwise, insulate above the floor. Check that low density blockwork is suitable for the ground conditions and acceptable structurally (Figure 62).



See 5.3(i)

Figure 62 Avoiding thermal bridges in reinforced suspended slabs

5.3(j) At stepped separating walls, insulate within the cavity down to foundation level, as described in *5.3(g)*, (Figure 60).

5.4 Damage from moisture in the floor

The drying out of residual moisture in the concrete slab or screed can damage moisture-sensitive floor finishes.

5.4(a) Locate the dpm above the slab if there is any doubt whether the slab will have dried out to an acceptable moisture content for the chosen floor finish. A 100 mm in-situ concrete slab can take up to 6 months to dry sufficiently to receive moisture-sensitive flooring. Wetting by rainwater can increase this time considerably.

5.4(b) Use a sheet, or a hot- or cold-applied, dpm above the slab and ensure it links with the wall dpc.

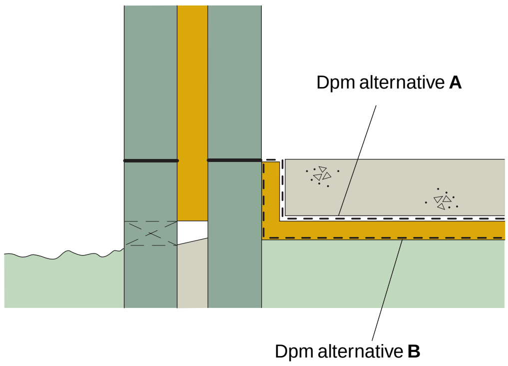
5.4(c) If there is no doubt that the concrete will dry out, lay the dpm below the slab.

Ground supported slabs

5.4(d) Where the dpm is to be below the slab (Figure 63), lay it either:

A: above the insulation if the insulation is resistant to ground contaminants, *or*

B: below the insulation if the insulation is not resistant to ground contaminants.



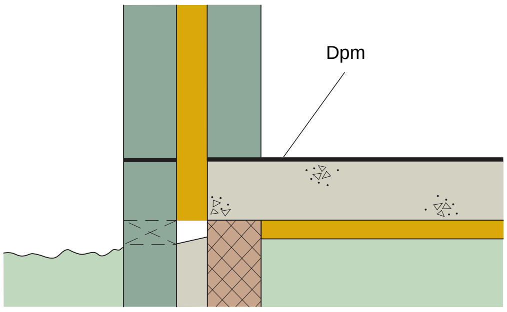
See 5.4(d)

Figure 63 Dpm positions below a ground supported slab

Reinforced suspended slabs

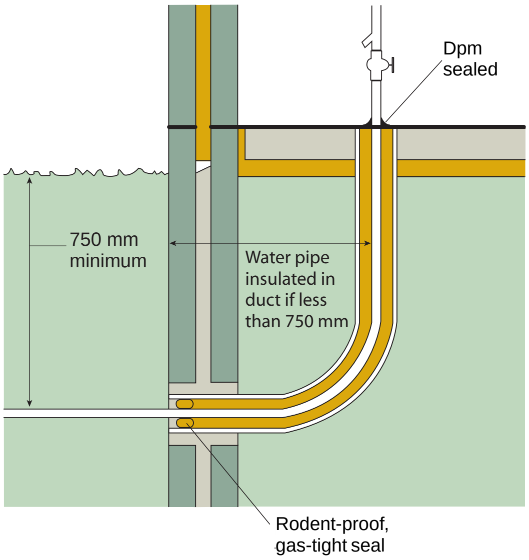
5.4(e) Locate the dpm above a reinforced suspended slab and link with the wall dpc (Figure 64).

5.4(f) Ensure that the insulation material is resistant to water and contaminants (Figure 64).



See 5.4(e), (f)

Figure 64 Dpm located above a reinforced suspended slab



See 5.5(b)–(d)

Figure 65 Insulation to a cold water supply through floors in contact with the ground

5.5 Risks associated with services

Water supply pipes below floor insulation can be damaged by frost. Services within the floor can be damaged by fixings or frost. They can also cause dampness when they puncture damp proof membranes. Some water services need to be accessible for replacement or repair.

5.5(a) Avoid laying services in the floor slab if the dpm is above the slab as it is difficult to maintain effectively the integrity of the membrane.

5.5(b) Insulate the cold water supply pipe throughout its length when it enters the building less than 750 mm from the outside face of the external wall (Figure 65). Refer to *Appendix B* to establish the thickness of insulation required to delay freezing.

5.5(c) Seal the damp proof membrane where pipes pass through the floor (Figure 65).

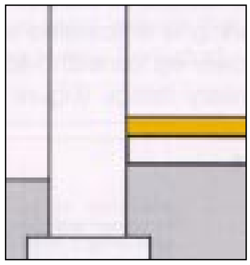
5.5(d) Make a rodent-proof, gas-tight seal where the water supply pipe enters the building using expanding foam with cement mortar pointing (Figure 65).

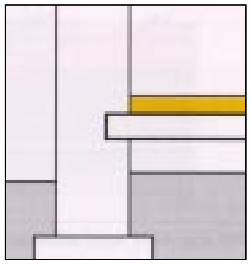
5.5(e) Run water supply pipes in a duct with an accessible cover, wherever practicable.

5.5(f) Insulate central heating pipes and provide at least 25 mm cover of screed or, if in a power floated slab, run the pipes in a duct.

5.5(g) Provide at least 25 mm cover to gas pipes and electrical conduit either in a power floated slab or a screed.

Concrete ground floors insulated above the structure





Characteristics of the construction

With precast concrete beam and block suspended floors insulation is normally placed above the structure. However, the technique is suitable with cast in-situ floors provided the dpm is above the slab.

The insulation material should be rigid and suitable for the loading requirements. The insulation can be below a timber-based flooring system or below a screed.

Insulated timber-based flooring systems can be laid as:

- composite panels in which the insulant is bonded to the timber-based board,
- loose-laid systems in which the insulant and the boards are installed separately,
- timber battened systems in which the battens support the flooring panels and insulation is laid between the battens.

R This insulation method is relevant if a timber suspended floor is to be replaced by a precast concrete system or an in-situ concrete slab, or if it is convenient to lay insulation above an existing concrete floor.

Associated technical risks

5.6 Failure in service
5.7 Damage to the insulation during construction
5.8 Damage from moisture
5.9 Condensation at thermal bridges
5.10 Risks associated with services

Risks and avoiding actions

5.6 Failure in service

Failure in service can result from uneven support, incorrect installation of flooring panels, insufficient thickness and strength of screed or inappropriate choice of insulation.

5.6(a) Ensure that the surface of the concrete slab or precast flooring is flat (up to 5 mm under a 3 metre straight edge is acceptable), clean and free from mortar or plaster droppings.

A roughly tamped concrete surface is not suitable without being levelled, whereas a smooth floated surface will be suitable without special treatment. Some precast plank or beam and block floors will provide a suitable base if the levelling layer is floated off evenly. Others are less accurate, eg where beams with a camber meet at right angles, and these require a levelling screed.

5.6(b) Choose an insulation board with adequate compressive strength for the intended loading when it supports timber-based panels or screed.

Timber-based flooring

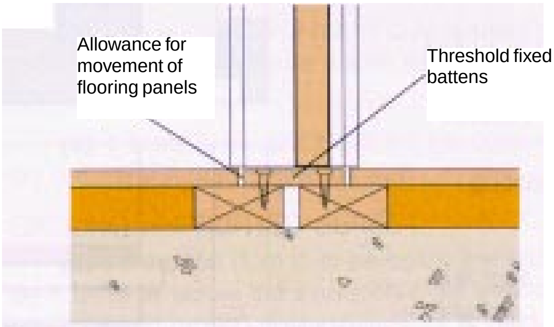
5.6(c) Fit tongued and grooved panels tightly together and glue all joints evenly with a PVA adhesive. Wedge the panels temporarily at the perimeter until the glue has set.

Failure to achieve an even surface to support the insulation can result in the glued joints breaking apart, causing a squeaky floor. Consider using a separation layer to prevent timber-based flooring from squeaking on rigid plastics board insulation.

5.6(d) Provide an expansion gap of at least 10 mm between timber-based particle board flooring panels and perimeter walls or other rigid upstands. When the width of floor between walls or upstands is more than 10 metres, allow a total expansion gap of 2 mm per metre width, distributed between opposite edges of the floor. Some manufacturers recommend an extra gap at an intermediate position across the floor.

5.6(e) Support edges of the panels at door openings on preservative-treated timber battens. Ensure that the battens are on a firm and level base and fix a separate strip of flooring to the battens as a threshold. Allow a gap each side of the threshold for movement in the flooring panels.

Use additional support battens where extra floor loading is anticipated and the exact position is known, eg beneath kitchen or sanitary fittings and equipment (Figure 66).



See 5.6(e)

Figure 66 Extra support and allowance for movement at doorways

5.6(f) When required, use a levelling screed to ensure that the battens of a timber battened system are true and level. Do not attempt to fix the flooring to the battens through resilient insulation material as this will create an uneven floor surface.

5.6(g) Lightly sand and sweep chipboard floors to make the surface suitable for thin flooring such as flexible PVC sheet. Do not wash or scrub with water.

Screed finish

5.6(h) Use a cement:sand screed of 1:3 to 1:4.5 mix by weight, laid to a minimum thickness of 65 mm for domestic construction and 75 mm elsewhere.

Ensure that the screed is thoroughly compacted throughout its thickness, particularly above resilient insulation. If necessary, place and compact in two layers.

5.6(i) Lay a separating layer of building paper or 500 gauge (0.12 mm) polyethylene sheet above fibrous insulation to prevent the wet screed soaking into the insulation (Figure 67).

5.6(j) Tape the joints of rigid insulation boards so that wet screed does not penetrate the joints (Figure 67).

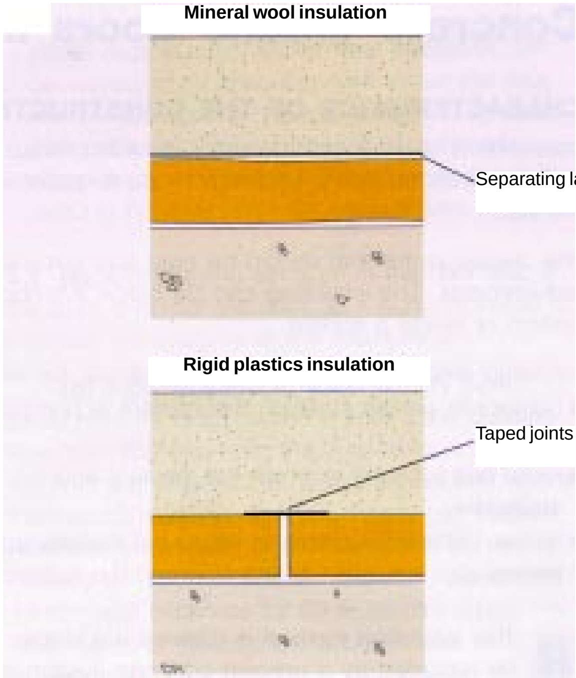
5.7 Damage to the insulation during construction

Insulation may be damaged by chemical reaction with solvents present in some liquid damp proof materials and adhesives. When screeds are being laid the insulation and the separating layer may be damaged.

5.7(a) Check the chemical compatibility of liquid dpm materials with the insulation material. Some pitch and bitumen-based materials can degrade polystyrene.

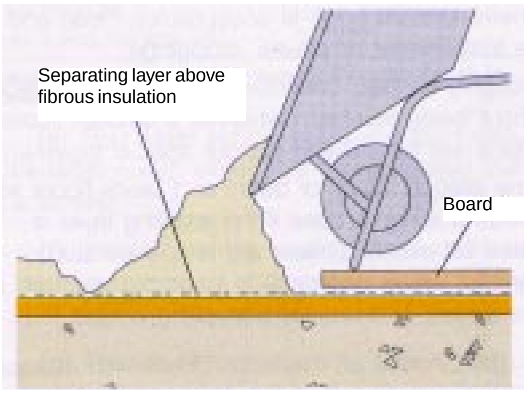
Ensure that the insulation is not laid until the solvents from liquid dpm materials have fully evaporated.

5.7(b) Use temporary boards to protect the insulation when barrowing screed material and tipping the wet mix into place (Figure 68).



See 5.6(i), (j)

Figure 67 Construction of insulated screeds



See 5.7(b)

Figure 68 Protection when laying screeds above insulation

5.8 Damage from moisture

Moisture-sensitive floorings and timber-based flooring panels, particularly those of chipboard, can be damaged by water vapour emanating from moisture in the floor construction.

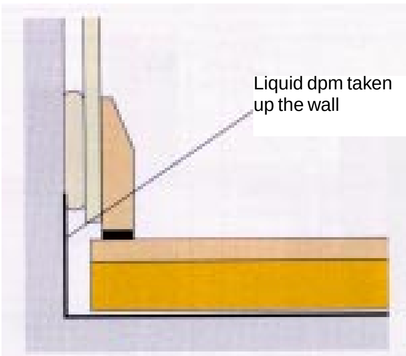
5.8(a) For suspended floors of precast construction, introduce a separate 500 gauge (0.12 mm) polyethylene vapour control layer above the floor to protect timber-based flooring panels and any moisture-sensitive floor finishes (Figures 70–72).

Although precast concrete floors are essentially dry, protection is needed against residual moisture absorbed during construction or from exposure to the weather.

5.8(b) For in-situ concrete floors lay the dpm above the slab. Where a dpm has been positioned below the in-situ concrete floor introduce an additional 500 gauge (0.12 mm) polyethylene vapour control layer above the slab to protect timber-based flooring panels and any moisture-sensitive floor finishes.

5.8(c) To prevent residual dampness in the wall affecting the edge of the flooring:

- apply the liquid dpm up the wall (Figure 69), *or*
- turn a polyethylene dpm up the wall or back across the top of the flooring. Ensure that the dpm links with the wall dpc.

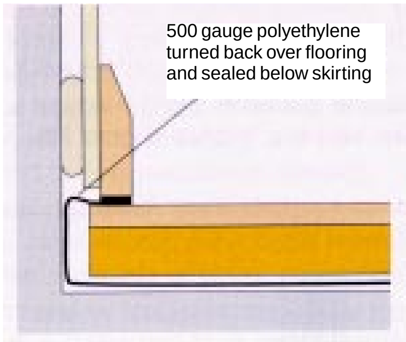


See 5.8(c), 5.9(d)

Figure 69 Dpm turned up wall to protect edge of flooring

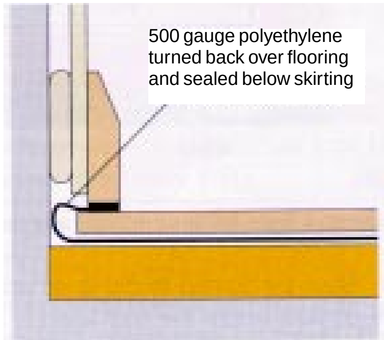
5.8(d) Where there is no dpm above the floor, protect the edge of flooring from moisture in the wall with a vapour control layer and turn up the wall or back across the floor as described in *5.8(c)* (Figures 70–72).

5.8(e) Seal the skirting to the flooring to prevent moist air from within the building reaching the structural floor. Sealing the surface of the flooring is the most effective way of avoiding the small risk of condensation within the floor construction (Figures 70–72).



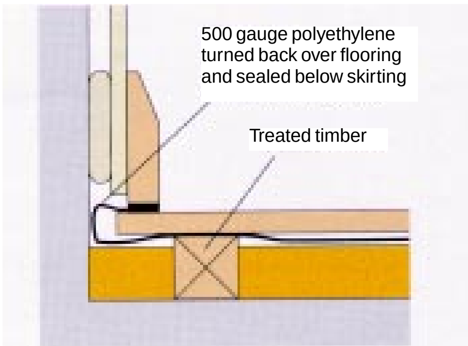
See 5.8(a), (d), (e), (f), 5.9(d)

Figure 70 Vapour control layer beneath composite panels



See 5.8(a), (d), (e), (f), 5.9(d)

Figure 71 Vapour within a loose-laid system sealed at the skirting



See 5.8(a), (d), (e), (f), 5.9(d)

Figure 72 Vapour control layer within a timber battened system sealed at the skirting

Timber-based flooring

5.8(f) Position the vapour control layer, preferably between the finished floor panels and the insulation (Figures 71 and 72). Since composite panels with plastics insulation have a high vapour resistance, it is acceptable to locate the vapour control layer beneath the insulation (Figure 70). If a liquid vapour control layer is used, ensure that the surface of precast flooring is free from dust and loose material.

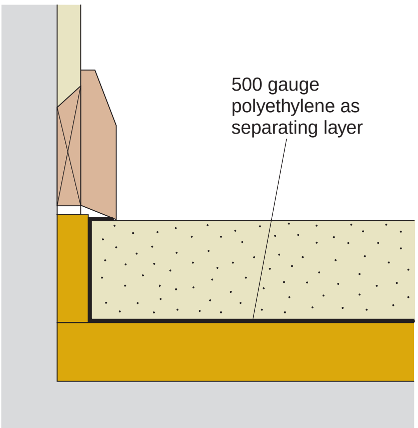
5.8(g) Seal any services that penetrate the damp proof membrane or vapour control layer with a flexible sealant or tape. Ensure that all holes made when fixing services are sealed.

5.8(h) Limit the potential for damage to timber-based flooring panels by using moisture-resistant types.

Screed finish

5.8(i) If there is no dpm above the concrete floor (precast or in-situ), place a vapour control layer of 500 gauge (0.12 mm) polyethylene between the insulation and the screed to protect moisture-sensitive finishes (Figure 73).

5.8(j) Allow the screed to dry to an appropriate moisture content before the floor finish is laid.



See 5.8(i), 5.9(e)

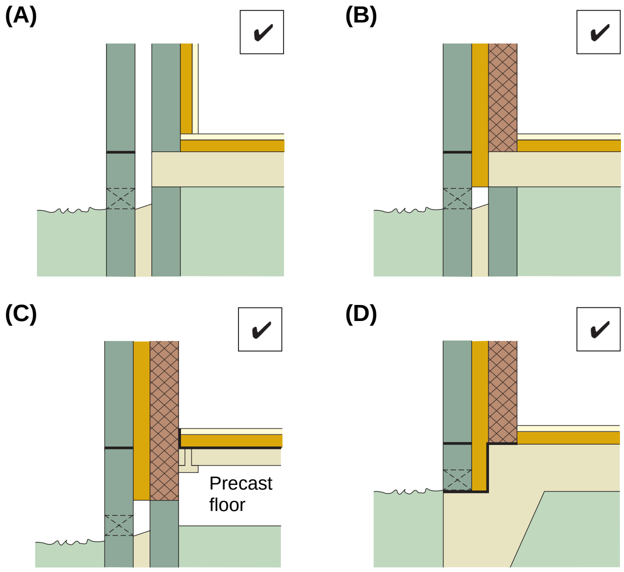
Figure 73 Vapour control layer between screed and insulation

5.9 Condensation at thermal bridges

There is a potential thermal bridge at the junction of the floor and the external wall, in particular at the threshold of external doors and where insulation is omitted around service pipes or ducts.

5.9(a) Achieve insulation continuity by using insulation above the floor structure in conjunction with internal wall insulation, either as timber frame or as an insulated internal lining (Figure 74A).

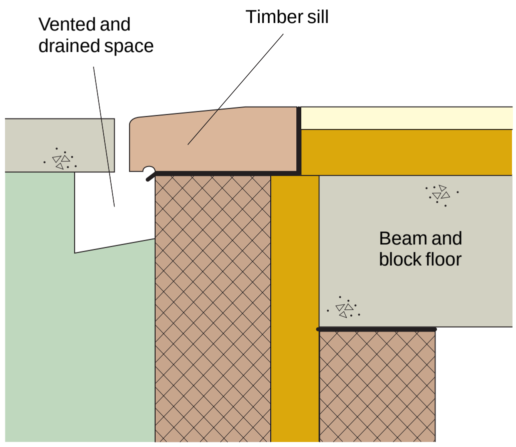
5.9(b) Ensure there is at least a 150 mm overlap between cavity wall insulation and the floor insulation. Position the cavity wall insulation below the level of the bottom of concrete slabs or suspended precast concrete floors, or down to the base of concrete rafts. Additionally, the use of low density blocks for the inner leaf of the wall or for precast flooring built into the wall minimises the risk of thermal bridging. The use of high density blocks in these circumstances is not recommended (Figures 74B–D).



(A) See 5.9(a); **(B)** See 5.9(b); **(C)** See 5.9(b); **(D)** See 5.9(b)

Figure 74 Avoiding thermal bridges in ground supported slabs

5.9(c) Position the door frame within the reveal so that the threshold overlaps the wall insulation. Ensure the floor insulation is continuous with the wall insulation and extends below the threshold (Figure 75). Provide protection, in accordance with local exposure and ground conditions, to the threshold.



See 5.9(c)

Figure 75 Avoiding thermal bridge at threshold

Timber-based flooring

5.9(d) Butt insulation boards against the external wall, except when using composite flooring panels which require an expansion gap. This expansion gap should not significantly increase the risk of condensation from thermal bridging (Figures 69–72).

Screed finish

5.9(e) Insert a vertical strip of insulation at the perimeter of the floor, the full depth of the screed on top of the floor insulation, to avoid the thermal bridge between the screed and the masonry wall. Choose an insulation thickness which ensures that the strip is covered by the wall finish and skirting (Figure 73).

5.10 Risks associated with services

Water supply pipes below floor insulation can be damaged by frost. Services within the floor can be damaged by fixings which can also puncture damp proof membranes or vapour control layers resulting in dampness. Some water services need to be accessible for replacement or repair. PVC sheathing to cables can have reduced life expectancy if in direct contact with expanded polystyrene insulants.

5.10(a) Ensure that damp proof membranes and vapour control layers are effectively sealed if penetrated by services or fixings for services (Figure 76).

5.10(b) Insulate cold water supply pipes throughout their length if they pass through a ventilated subfloor irrespective of their distance from the external wall (Figure 76). For the recommended insulation thickness, refer to *Appendix B*.

5.10(c) Make a rodent-proof, gas-tight seal where the water supply pipe enters the building using expanding foam with cement mortar pointing (Figure 76).

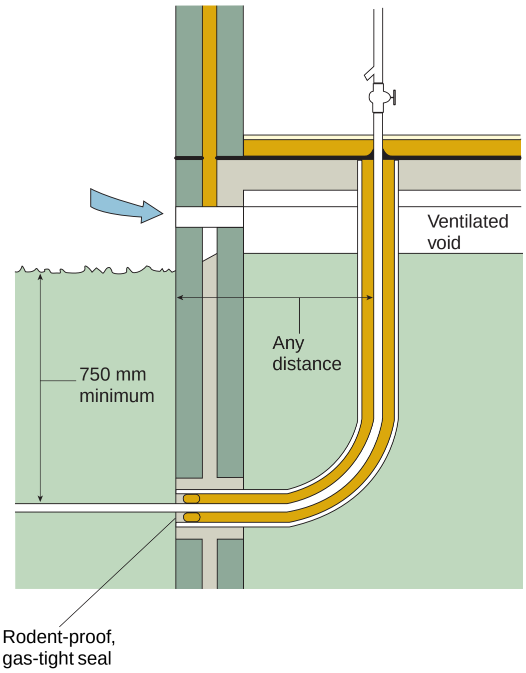
5.10(d) Check all connections and valves for tightness before filling pipework with water to avoid damage to insulated flooring.

Timber-based flooring

5.10(e) Run water supply pipes in a duct within the insulation thickness and provide a cover for access.

5.10(f) Insulate central heating pipes to concentrate heat output at the heat emitters. Run the pipes in ducts within the insulation thickness and provide access where appropriate.

5.10(g) Seal around all pipes penetrating the floor to prevent water from leaks or drain valves collecting below the flooring.



See 5.10(a), (b), (c)

Figure 76 Insulation to a cold water supply through a suspended ventilated floor

5.10(h) Run gas pipes on top of the structural floor within the insulation thickness.

5.10(i) Run electric cables in conduit to avoid contact between PVC sheathing and polystyrene insulation and to limit mechanical damage. Route the conduit within the insulation thickness and specify metal conduit if the cable is within 50 mm of the underside of timber-based flooring.

Cables enclosed by insulation, especially those serving cooker points and high output heaters, may need to be de-rated (increased in size), even when in conduit (see *Appendix A*).

Screed finish

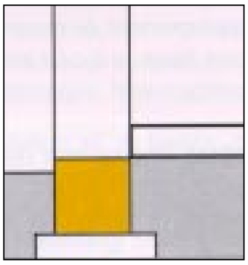
5.10(j) Run water supply pipes within the screed in a duct with an accessible cover.

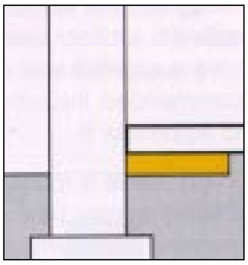
5.10(k) Insulate central heating pipes to concentrate heat output at heat emitters and cover them with at least 25 mm of well compacted screed. Reinforcement or extra cover may be needed in areas with heavy traffic.

5.10(l) Run gas pipes below the screed within the insulation.

5.10(m) Run electrical cables in conduit to avoid direct contact with polystyrene insulation. Route conduit within the insulation and de-rate the cables as necessary (see *Appendix A*).

Concrete ground floors insulated at the edge





Characteristics of the construction

Insulation is concentrated only at the edge of the floor and positioned either horizontally or vertically for a distance of up to 2 metres, depending on the size and shape of the building and the insulation thickness.

When placed vertically, it can be located:

- on the inside of the external walls,
- within the cavities,
- on the outside of the wall.

Depending on the depth and type of foundation, insulation may be required to the foundation itself, as well as to the wall.

In a few cases, the required U-value may be achieved using only low conductivity solid blockwork for the wall from ground level to the foundation.

R Vertical insulation applied externally may be useful where it is not feasible to upgrade the floor within the building, but it is possible to add insulation to the outside face of the substructure wall if the foundation depth is sufficient. This is particularly useful in conjunction with external wall insulation and it can also be used as a remedy for surface condensation on concrete ground slabs.

Associated technical risks

5.11 Reduced thermal performance of insulating materials below ground
5.12 Damage during construction
5.13 Structural failure of the substructure
5.14 Condensation at thermal bridges

Risks and avoiding actions

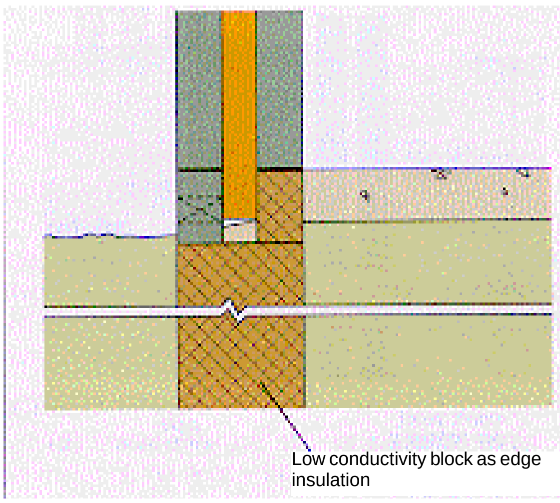
5.11 Reduced thermal performance of insulating materials below ground

If the insulation absorbs moisture or is degraded by contaminants in the ground or fill, its thermal performance will be reduced.

5.11(a) Choose an insulant with very low water absorption characteristics. If it is to be in direct contact with the ground or fill, choose a type which will not react chemically with any contaminants present in the ground or fill.

5.11(b) Use a low conductivity block, where this will achieve the required insulation value, which has low water absorption, sufficient structural strength and is resistant to frost and ground contaminants (Figure 77).

5.11(c) Choose a cavity insulation which is free draining or closed cell and provides drainage to remove water from the cavity at foundation level (Figure 80).



See 5.11 (b), 5.12(a)

Figure 77 Solid blockwork used as edge insulation

5.12 Damage during construction

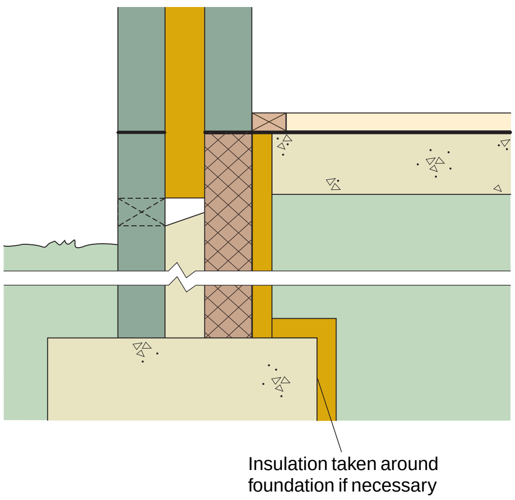
Since the insulation is installed in conjunction with groundworks, it may be damaged by machinery or by general building operations.

5.12(a) Use an insulant which has sufficient strength to resist damage from the process of concreting or trench backfilling.

The greatest resistance to damage is provided by solid blockwork, provided it has sufficient thermal resistance to act as edge insulation (Figure 77).

5.12(b) Fix internal vertical edge insulation to the face of masonry walls so that it is held firmly in position before backfilling against it. It may be necessary to insulate around strip footings or trench fill, depending on the required depth of insulation (Figure 78).

5.12(c) Protect externally applied vertical, edge insulation below dpc level by a board, render on metal lath or paving slabs.



See 5.12(b)

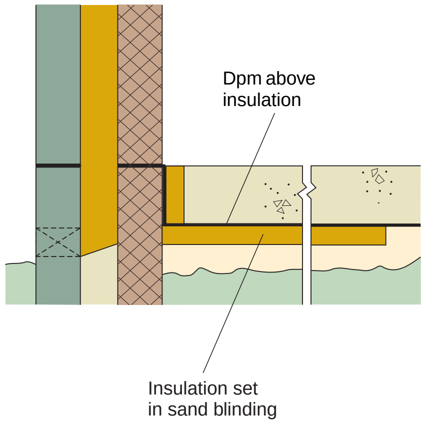
Figure 78 Vertical edge insulation on internal face of wall

5. 13 Structural failure of the substructure

The introduction of thermal insulation materials into the substructure can affect the structural stability of the ground slab and of the external walls below ground level.

5.13(a) Ensure that the support given to the concrete slab by the horizontal strip of insulation and the remainder of the floor slab is constant.

5.13(b) If horizontal edge insulation is set into the sand blinding, the same thickness of concrete slab can be used across the whole floor (Figure 79).



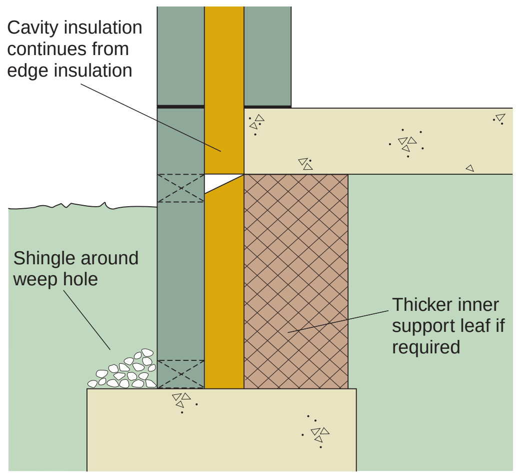
See 5.13(b)

Figure 79 Horizontal edge insulation below concrete slab

5.13(c) If horizontal insulation is laid above the dpm, increase the overall slab thickness to ensure that the minimum required thickness is maintained.

5.13(d) When vertical edge insulation is placed in a cavity wall down to foundation level, ensure that inner and outer leaves are tied together at 450 mm above foundation level and thereafter to suit the coursing of the internal blockwork and the cavity wall insulation. Use stainless steel ties below ground level (Figure 80).

5.13(e) Thicken the inner loadbearing leaf of a cavity wall, which is to be insulated to foundation level, where the distance from the underside of the slab to the foundation is more than 600 mm, particularly where it cannot be guaranteed that the trench will be backfilled and compacted evenly in stages on each side of the wall (Figure 80).



See 5.11(c), 5.13(d), (e)

Figure 80 Vertical edge insulation within a cavity wall

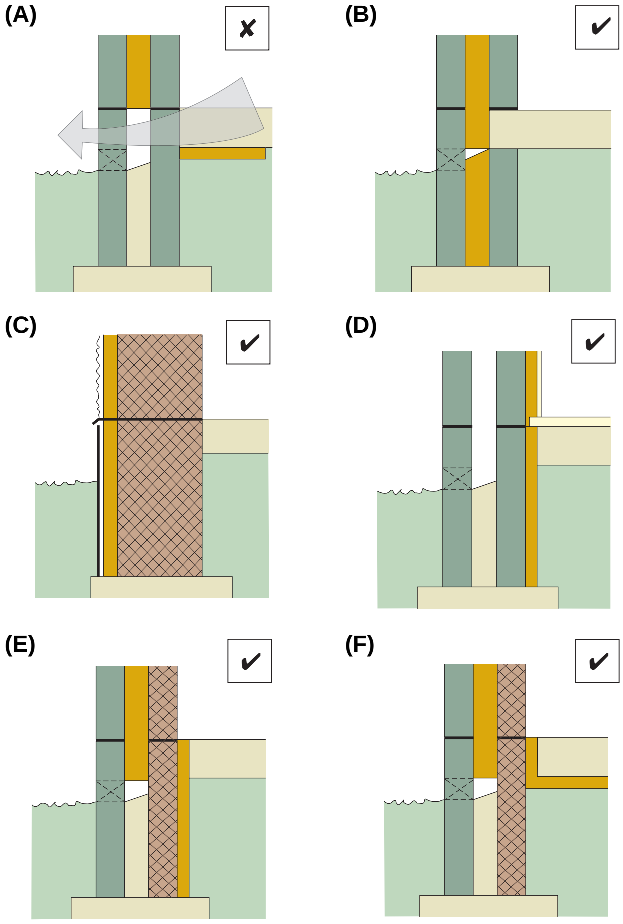
5.14 Condensation at thermal bridges

A thermal bridge is created and surface condensation can occur where there are breaks in the continuity of the insulation layers.

5.14(a) Avoid a thermal bridge at the junction of wall and floor (Figure 81A) by:

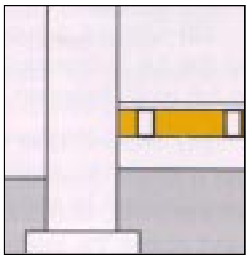
- achieving continuity of insulation in the same plane, ie internal vertical edge insulation with internal wall insulation (Figure 81D), cavity edge insulation with cavity wall insulation (Figure 81B) and external edge insulation with external wall insulation (Figure 81C) *or*
- insulation layers overlapping by at least 150 mm and linking them with low density blockwork (Figures 81E and F).

5.14(b) Ensure that the edge of the screed is insulated when it links internal wall insulation and internal vertical edge insulation (Figure 81D).



(A) See 5.14(a); **(B)** See 5.14(a); **(C)** See 5.14(a);
(D) See 5.14(a), (b); **(E)** See 5.14(a); **(F)** See 5.14(a)

Figure 81 Avoiding thermal bridges in concrete ground floors



Suspended timber ground floors

Characteristics of the construction

The advantage of this type of floor is that the required thickness of insulation can be accommodated relatively easily within the thickness of the floor structure. The insulation materials may be mineral wool quilt supported on netting or rigid boards of plastics or mineral wool supported on timber battens.

R Relevant when the flooring and possibly the joists of an existing suspended timber floor need to be renewed or where insulation can be fitted below an existing floor.

Associated technical risks

5.15 Increased heat loss due to air movement and reduced insulation thickness
5.16 Condensation at thermal bridges
5.17 Damage from moisture
5.18 Risks associated with services

Risks and avoiding actions

5.15 Increased heat loss due to air movement and reduced insulation thickness

The heat loss through the floor is increased if cold air is able to enter the building from the subfloor space, where gaps in the insulation layer allow air movement above the insulation or where the insulation is reduced in thickness.

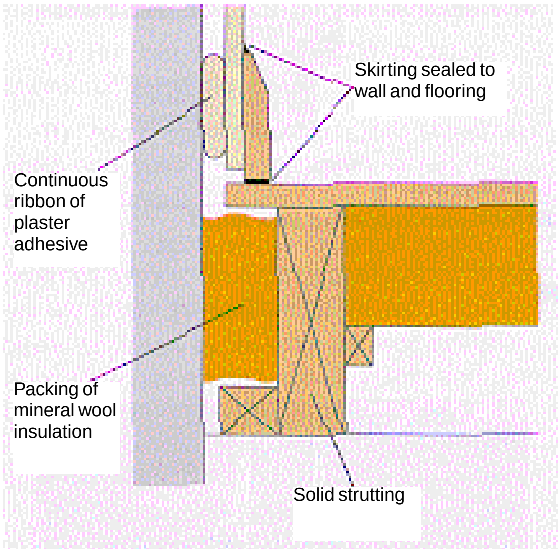
5.15(a) Use full depth strutting between the joists at the perimeter of the floor to provide a fixing for the flooring and to limit the size of gaps which need to be sealed at the edge of the floor (Figure 82).

5.15(b) Seal the skirting to the wall with a sealant, and to the floor with a flexible sealant or an extruded draughtproofing section. Also seal the gaps at services penetrations and access panels in the flooring (Figure 82).

5.15(c) Pack the space between the wall and the joist or solid strutting with mineral wool insulation (Figure 82).

5.15(d) Ensure that the space between plasterboard dry lining and masonry walling is sealed by applying continuous ribbons of plaster adhesive, particularly at skirting level (Figure 82).

5.15(e) Position the insulation level with the top of the joists to avoid any air movement between the insulation and the flooring (Figures 82 and 84). This may be less critical where the movement of cold air from the subfloor space, through or around the insulation, is restricted, eg by using support boards for quilt installation (Figure 83) or tightly butted plastics insulation boards (Figure 85).



See 5.15(a)–(e)

Figure 82 Insulating and sealing the floor at the perimeter of the floor

Quilt insulation

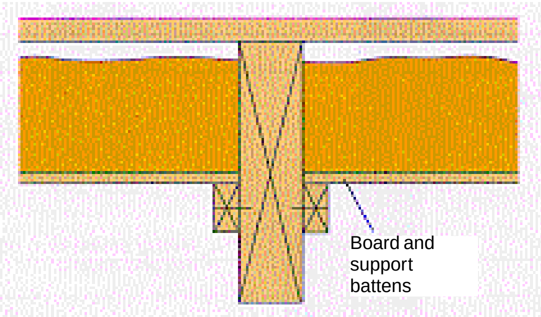
5.15(f) Avoid draping insulation over the joists as its thickness will be reduced substantially either side of each joist, and the uneven support will lead to loose fixings and a squeaky floor.

5.15(g) Choose a support method which ensures that the full thickness of insulation is maintained for the full width between the joists.

5.15(h) Support quilt insulation, either:

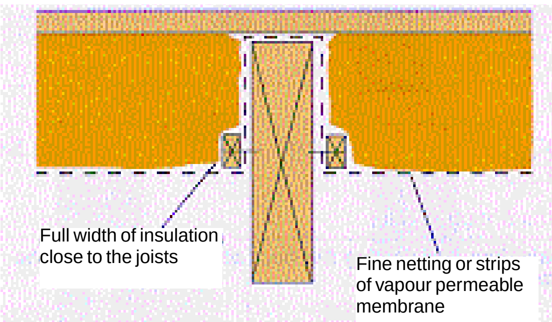
- on a board, fixed to battens nailed to the sides of the joists, to reduce air movement through and above the insulation (Figure 83), *or*
- on plastics netting or strips of vapour permeable membrane when using large tongued and grooved flooring panels which themselves create an airtight layer. Fine netting may be draped over the joists and held against the sides with staples or battens (Figure 84).

Consider laying a vapour permeable membrane, with sealed joints, below the flooring where additional airtightness is required.



See 5.15(e), (h)

Figure 83 Quilt insulation supported on a board



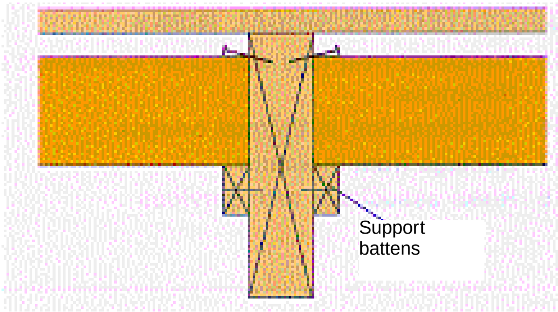
See 5.15(e), (h)

Figure 84 Quilt insulation supported on netting or vapour permeable membrane

Plastics board insulation

5.15(i) Support rigid plastics boards on battens fixed to the sides of the joists and hold the boards down against the battens with nails driven into the joists (Figure 85). Do not support insulation boards on nails or clips, unless the insulation is tight to the underside of the flooring, since any gap due to the inaccurate cutting of the boards will allow cold air to by-pass the insulation.

Consider laying a vapour permeable membrane, with sealed joints, below the flooring where additional airtightness is required.



See 5.15(e), (i)

Figure 85 Plastics board insulation supported on battens

5.16 Condensation at thermal bridges

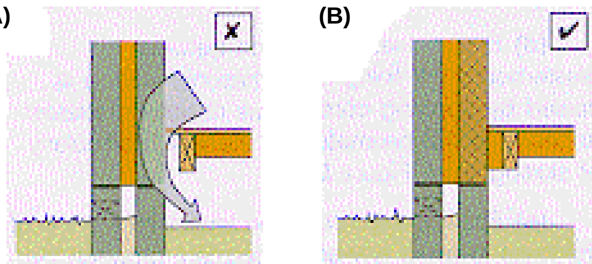
Condensation can occur on the surface of the wall or floor where there is a thermal bridge between the inside of the building and the cold subfloor space. This can be via the external wall or the edge of the floor, particularly at thresholds.

5.16(a) Maintain insulation continuity by packing the space between the external wall and the joist or solid strutting with mineral wool insulation which can be cut, slightly oversize, to suit the space available. It will be an advantage to set out the first joist, or position solid strutting, at least 50 mm from the wall (Figure 86). Extend the cavity insulation at least 150 mm below the floor insulation.

5.16(b) Use low density blockwork in the thermal bridge path between the inside of the building and the subfloor space (Figure 86B) or choose a wall specification with an insulated internal lining.

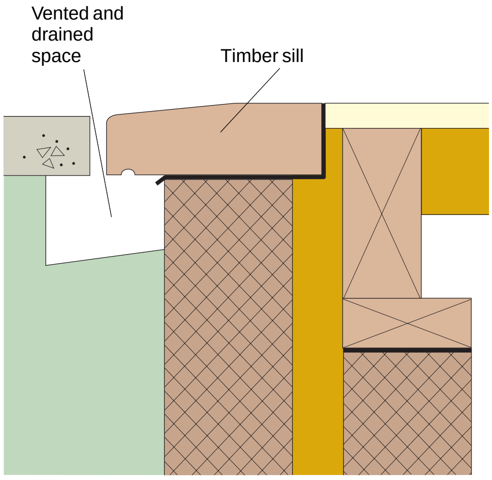
5.16(c) Position the door frame within the reveal so that the threshold overlaps the wall insulation. Ensure the floor insulation is continuous with the wall insulation and extends below the threshold (Figure 87). Provide protection, in accordance with local exposure and ground conditions, to the threshold.

(A) **(B)**



(A) See 5.16(a); **(B)** See 5.16(a), (b)

Figure 86 Avoiding thermal bridges in suspended timber ground floors



See 5.16(c)

Figure 87 Avoiding thermal bridge at threshold

5.17 Damage from moisture

Adequate cross ventilation of the subfloor space is necessary to keep timber and timber-based products dry as they can be damaged by moisture. Insulation below the flooring can restrict the space available for cross ventilation.

5.17(a) Cross ventilate the subfloor space with ventilators in at least two opposite walls, with a minimum free area of 1500 mm^2 per metre run of wall, or a total free area of 500 mm^2 per square metre of ground floor area, whichever is the greater.

5.17(b) Ensure that ventilators are not obstructed by floor insulation.

5.17(c) Where strutting is needed above sleeper walls, use herringbone strutting since solid strutting limits the ventilation area to that of the honey-combed sleeper wall.

5.17(d) Position floor insulation so that any ventilation provision over sleeper walls will not be obstructed.

5.17(e) It is not necessary to introduce a vapour control layer into insulated timber suspended floors since any small amounts of condensation that form will be safely ventilated away.

5.17(f) Limit damage to timber-based flooring panels by using moisture-resistant types.

5.18 Risks associated with services

Services within the floor can be damaged by fixings, frost, overheating or chemical reaction. Water supply pipes below floor insulation can be damaged by frost. Services within the floor can be damaged by fixings. Some water services need to be accessible for replacement or repair. PVC sheathing to cables can have reduced life expectancy if in direct contact with expanded polystyrene insulants. Holes for services reduce the airtightness of the floor.

5.18(a) Insulate cold water supply pipes as they pass through the ventilated subfloor, as described in *5.10(b)*.

5.18(b) Run central heating pipes above the floor insulation and insulate the pipes to concentrate heat output at the heat emitters.

5.18(c) Ensure that the floor insulation does not block ventilation paths to those solid fuel appliances which are designed to receive their air supply from the subfloor space.

5.18(d) Provide access at 2 metre intervals to cold water supply pipes which run horizontally within the floor using access panels in large timber flooring panels, or use removable floor boards.

5.18(e) Run gas pipes below the insulation, between or below the joists.

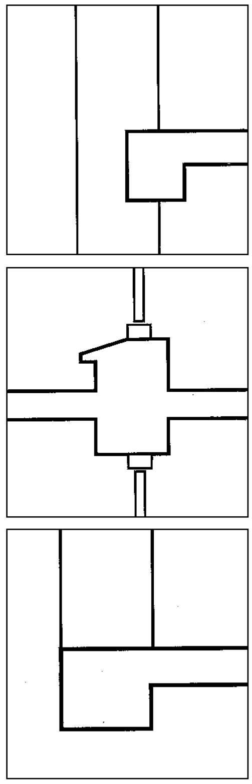
5.18(f) Avoid contact between PVC sheathed cables and polystyrene insulation, or run the cables in conduit.

5.18(g) Use cables with an earthed metallic sheath or run the cables in metal conduit when they are closer than 50 mm to the top of the joist.

Cables enclosed by, or close to floor insulation, especially those serving cooker points and high output heaters, may need to be de-rated (increased in size), even when in conduit (see *Appendix A*).

5.18 (h) Seal around services where they pass through the flooring.

Concrete and timber upper floors



Characteristics of the construction

Upper floors can be intermediate floors between flats or maisonettes, or floors whose soffit is exposed to the outside air. This section does not specifically apply to floors above unheated or ventilated spaces, although the principles outlined still apply.

Concrete floors are constructed in-situ, or use precast units. Floor slabs often have edge beams supported from masonry walls. Junctions with the external wall and where slabs project at balconies are the most difficult to detail.

Intermediate floors may need to be insulated to meet sound insulation requirements. Exposed floors always need to be insulated, either above, within or below the structure, to meet thermal requirements.

The insulation methods and products applicable to upper floors are often the same as those used for concrete and timber ground floors. However, external insulation and flat-roofing techniques are also applicable when, for example, insulating below exposed concrete soffits, or when insulating the tops of balconies.

R The insulation of intermediate and exposed floors is common when existing buildings are being converted or renovated. Buildings with a concrete frame with masonry infill present particular problems.

Associated technical risks

5.19 Condensation at thermal bridges
5.20 Condensation within the construction

Risks and avoiding actions

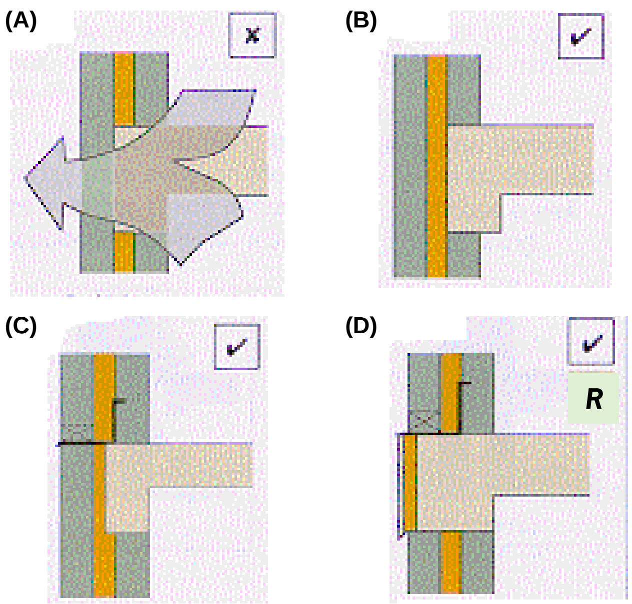
5.19 Condensation at thermal bridges

When a concrete intermediate floor has an edge beam built into a cavity external wall, the edge beam often projects into the cavity and the continuity of cavity insulation is broken, causing a thermal bridge. If the floor projects to the outside face of the wall, or beyond it to form a balcony, the insulation layer is similarly interrupted. Edge beams supporting the external wall at exposed floors create a potential thermal bridge and the risk of condensation.

Intermediate floors

5.19(a) Project wide concrete beams into the room (Figure 88B), not into the wall cavity (Figure 88A), to ensure continuity of cavity insulation. A projection, into the cavity, may be acceptable where the beam is insulated by some cavity insulation and a cavity tray protects this insulation (Figure 88C).

R **5.19(b)** Use cavity insulation in conjunction with external insulation on the face of the edge beam where circumstances permit, eg where the beam partially projects into the outer leaf and was previously finished with brick slips (Figure 88D).



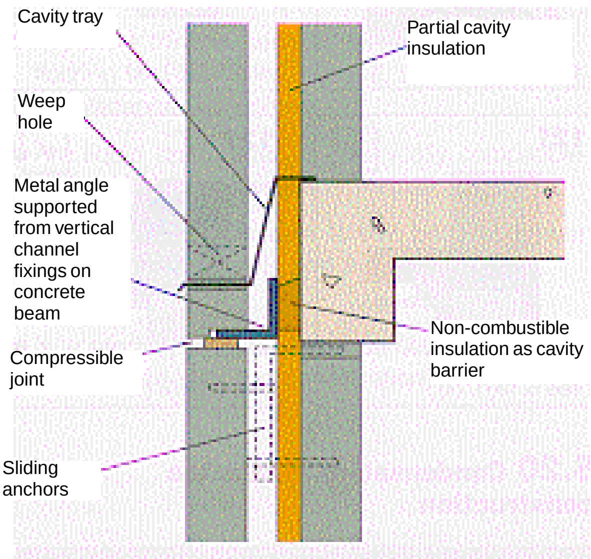
(A) See 5.19(a); **(B)** See 5.19(a); **(C)** See 5.19(a); **(D)** See 5.19(b)

Figure 88 Avoiding thermal bridges in concrete and timber upper floors

5.19(c) Where cavity insulation is interrupted or cavities extend over several storeys, take account of published guidance on:

- cavity trays and weep holes,
- damp proofing,
- fixings to concrete beams,
- allowance for movement in masonry,
- cavity fire barriers,
- support for the outer masonry leaf (Figure 89).

5.19(d) Avoid the thermal bridge created by the supporting flange of metal angles fixed directly to the concrete beam by fixing the angle to vertical support channels, with insulation behind the metal angle and between the support channels (Figure 89).



See 5.19(c), (d)

Figure 89 Detailing at edge beams with partial cavity insulation

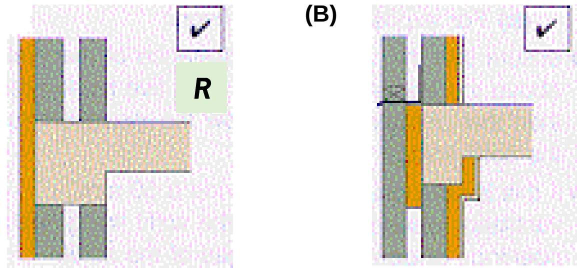
5.19(e) Use external insulation in preference to internal insulation since the floor slab or edge beam does not break the insulation layer.

R

5.19(f) Insulate with external insulation or insulated overcladding when concrete beams (and columns) are flush with the face of the external (infill) walling (Figure 90A).

5.19(g) If internal insulation is used in conjunction with cavity masonry walls, insulate the edge beam within the cavity and on internal surfaces (Figure 90B).

(A) **(B)**



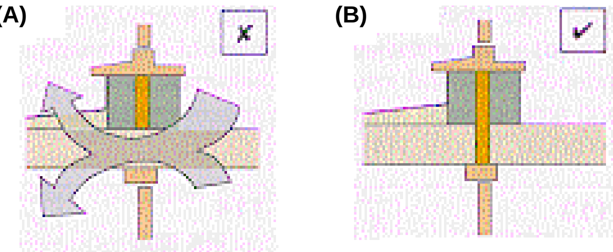
(A) See 5.19(f); **(B)** See 5.19(g)

Figure 90 Avoiding thermal bridge at edge beams

Balconies

5.19(h) Where possible, design balconies to be structurally separated from the floor slab so that the insulation can be continuous through the floor (Figure 91).

(A) **(B)**



(A) See 5.19(h); **(B)** See 5.19(h)

Figure 91 Avoiding thermal bridge at balconies

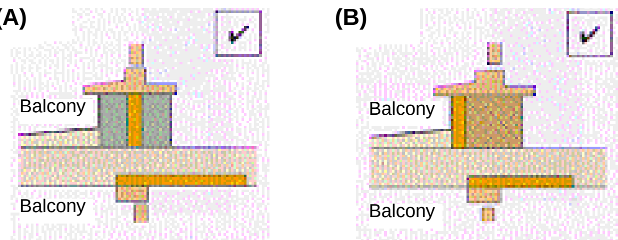
5.19(i) Where the floor and balcony slab is continuous, use cavity or external insulation. In addition, insulate the soffit of the slab, within the heated space, for a distance of at least 300 mm from the window/door frame or wall (Figure 92).

It is advantageous if the insulation is cast into the slab so that it extends above the door or window frame and does not disrupt the internal surface finish.

R

5.19(j) Where the floor and balcony slab is continuous, follow the guidance in *5.19(i)*, but surface fix the insulation and its protective finish (Figure 92).

(A) **(B)**



(A) See 5.19(i), (j); **(B)** See 5.19(i), (j)

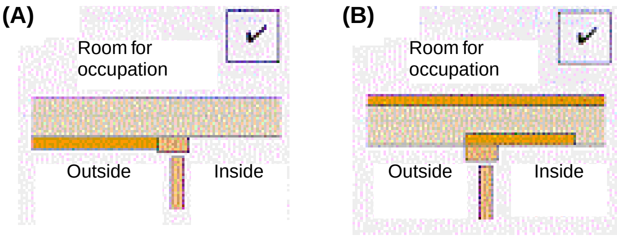
Figure 92 Avoiding thermal bridge at balconies

5.19(k) When rooms for occupation are above a balcony or access deck:

- insulate the entire soffit of the balcony (Figure 93A), *or*
- insulate the floor of the occupied room and the ceiling of the room below as in *5.19(i)* (Figure 93).

Use a vandal-resistant finish to insulation applied externally.

R **5.19(l)** When rooms for occupation are above a balcony or access deck, follow the guidance in *5.19(k)*, using surface-fixed insulation internally (Figure 93).



(A) See 5.19(k), (l); **(B)** See 5.19(k), (l)

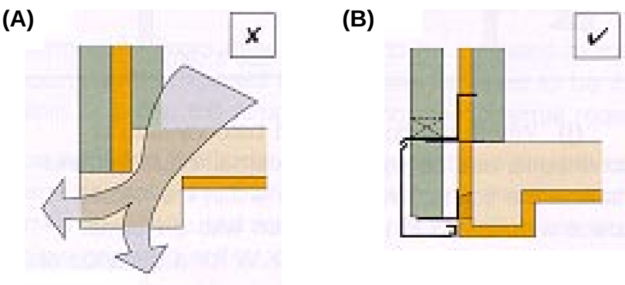
Figure 93 Avoiding thermal bridge below access decks

Exposed floors

5.19(m) For exposed floors, ensure that:

- there is continuity of external wall and floor insulation, *or*
- low density blockwork links overlapping layers of insulation (Figures 94 and 95).

5.19(n) Support the external leaf of cavity walls independently and insulate below concrete slabs and around edge beams to ensure insulation continuity (Figure 94B).

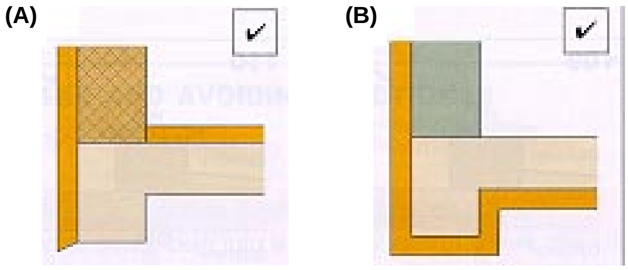


(A) See 5.19(m); **(B)** See 5.19(m), (n)

Figure 94 Avoiding thermal bridge at exposed floors

5.19(o) When external wall insulation is used:

- extend it around the edge beam to link with insulation below the slab (Figure 95B), *or*
- extend it down the face of the edge beam and use low density blockwork to link with insulation above the slab (Figure 95A).

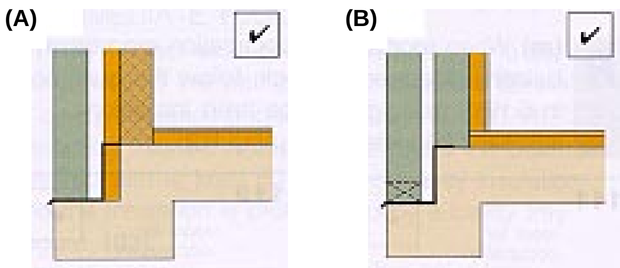


(A) See 5.19(m), (o); **(B)** See 5.19(m), (o)

Figure 95 Avoiding thermal bridge at exposed floors

5.19(p) Where the external leaf is supported by a concrete edge beam which is a continuation of the floor slab, use:

- low density blockwork in combination with cavity insulation (Figure 96A), *or*
- internal insulation and insulate above the concrete slab (Figure 96B).



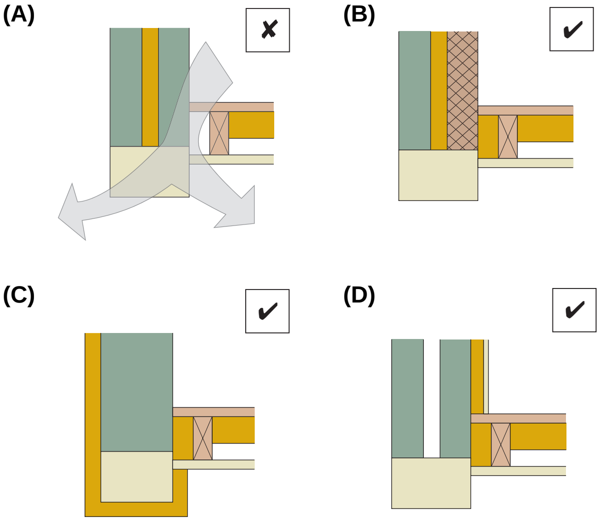
(A) See 5.19(p); **(B)** See 5.19(p)

Figure 96 Avoiding thermal bridge at exposed edge beams

5.19(q) For timber floors, ensure that the space between the wall and the joist or strutting is fully insulated (Figure 97).

5.19(r) To avoid a thermal bridge at the junction between insulated timber floors and edge beams:

- use cavity insulation in conjunction with an inner leaf of low density blockwork (Figure 97B), *or*
- extend external wall insulation around the edge beam to achieve continuity with the floor insulation (Figure 97C), *or*
- use internal wall insulation (Figure 97D).



(A) See 5.19(q); **(B)** See 5.19(q), (r); **(C)** See 5.19(q), (r);
(D) See 5.19(q), (r)

Figure 97 Avoiding thermal bridge with timber upper floors

5.20 Condensation within the construction

When internal linings, including insulated linings, cover cold surfaces, such as concrete edge beams and floor slabs close to the exterior, moisture from within the building can condense on the concrete and damage the insulation and/or lining.

Where exposed floors are insulated below the structure, condensation can occur within the floor if water vapour in the internal air cannot permeate through the construction.

5.20(a) At intermediate floors and balconies, ensure that internal linings to edge beams and adjacent ceilings are sealed or incorporate a vapour control layer to prevent moist air reaching cold concrete surfaces.

5.20(b) For exposed soffit floors:

- ensure that the vapour resistance of materials above the insulation is greater than that of materials below the insulation (eg the soffit lining), *or*
- if this is not possible, provide a 50 mm space behind the soffit lining ventilated to the outside by openings at opposite edges of the soffit, equivalent in area to a continuous 25 mm gap.

Quality control checks for floors

Concrete ground floors

- Is the dpm correctly positioned and continuous with the wall dpc?
- Is insulation tightly fitted and, when in contact with the ground, is it rigid, of low water absorption and, where necessary, resistant to chemicals?
- Are the insulation and dpm undamaged by the construction process of concreting or screeding?
- Is insulation at the edge of the floor installed when necessary to reduce thermal bridging?
- Is the cold water supply pipe insulated and the dpm sealed where penetrated by the pipe?
- Are services run beneath the flooring minimal and are they accessible for maintenance if required?
- Are liquid dpm materials chemically compatible with expanded polystyrene insulation?
- Is there a gap of at least 10 mm between timber-based flooring panels and the wall or rigid upstands?
- Is screeding over insulation carried out in accordance with the specification?

Suspended timber ground floors

- Is insulation supported beneath the flooring without gaps and is it packed into spaces at the floor edge between the wall and the joist or solid strutting?
- Are services correctly located and insulated as specified and is the floor insulation reinstated after installation of services?
- Is underfloor ventilation clear and not restricted through and over the sleeper walls and at perimeter wall ventilators?
- Is plasterboard bonded to masonry walling with a continuous ribbon of plaster adhesive at skirting level and is a flexible sealant applied between the flooring and the skirting and between the skirting and the plasterboard?

Concrete and timber upper floors

- Are special provisions followed as specified for reducing thermal bridging at the perimeter of intermediate floors, balconies and exposed floor slabs?

6

Appendices

Appendix A

Sizes for cables enclosed within thermal insulation

BS 7671:2001
Requirements for electrical installations

The presence of insulation around a cable has the effect of reducing the current carrying capacity and, in some cases, this will require the cable to be increased in size to safely carry the load.

In general, the effect of cables being enclosed by insulation is as follows:

- circuits run within thermal insulation must be protected with cartridge fuses or mini-circuit breakers (MCBs). Rewirable fuses are not suitable.
- cables fully enclosed by insulation (Figure 98) may need to be increased in size above the standard recommended size by as much as 20% if they pass at right angles through an insulating layer, and as much as 50% if they are enclosed along their length for more than 500 mm.
- for cables enclosed by insulation but in contact with a thermally conductive surface on one side (Figure 99), the larger of the standard recommended sizes will generally need to be used.

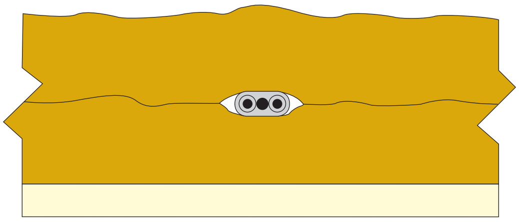


Figure 98 Cable fully enclosed within insulation

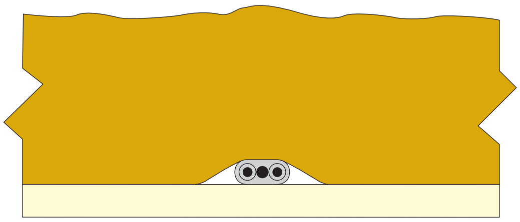


Figure 99 Insulation above cable on plasterboard ceiling

Appendix B

Insulation thickness for water supply pipes

BS 6700:1997

Design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages

Table 2 Insulation thickness for water supply pipes

Outside diameter (mm)	Thermal conductivity of insulation (W/m.K) 0.025	0.035	0.045	0.055
	Thickness of insulation (mm)			
15	30	62	124	241
22	12	20	30	43
28	8	12	17	23
35	6	9	12	15
42	5	7	9	11

Notes:

(1) The thickness of insulation under the respective thermal conductivity values is considered reasonable to provide upto 24 hours' protection in normally occupied buildings. Absence in excess of 24 hours is not considered normal occupation. In unoccupied buildings, and where severe weather conditions prevail, additional protection will be required.

(2) The conditions assumed for the table are:

- ambient temperature – 3 °C
- water temperature + 5 °C
- ice formation 50%

Appendix C

Sources of information

British Standards Institution

bsi-global.com

BS 476 Fire tests on building materials and structures

BS 747 Reinforced bitumen sheets for roofing specification

BS 3921 Specification for clay bricks

BS 5250 Code of basic data for the design of buildings: the control of condensation in dwellings

BS 5262 Code of practice for external renderings

BS 5534 Code of practice for slating and tiling

BS 5618 Code of practice for thermal insulation of cavity walls (with masonry or concrete inner and outer leaves) by filling with ureaformaldehyde (UF) foam systems

BS 5628 Code of practice for use of masonry. Part 3 Materials and components, design and workmanship

BS 6232 Thermal insulation of cavity walls by filling with blown man-made mineral fibre Part 1 Specifications for the performance of installation systems

BS 6576 Code of practice for installation of chemical damp proof courses

BS 6676 Thermal insulation of cavity walls using man-made mineral fibre bats (slabs) Part 2 Code of practice for installation of bats (slabs) filling the cavity

BS 6700 Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages

BS 7671 Requirements for electrical installations, IEE Wiring Regulations, sixteenth edition

BS 8104 Code of practice for assessing exposure of walls to wind driven rain

BS 8208 Guide to assessment of suitability of external cavity walls for filling with thermal insulants Part 1 Existing traditional cavity constructions

BS 8215 Code of practice for design and installation of damp proof courses in masonry construction

Building Research Establishment

bre.co.uk

BRE Building Elements series

Roofs and roofing — performance, diagnosis, maintenance, repair and the avoidance of defects. H W Harrison. BR 302. 1996
Floors and flooring — performance, diagnosis, maintenance, repair and the avoidance of defects. P Pye & H W Harrison. BR 332. 1997
Walls, windows and doors — performance, diagnosis, maintenance, repair and the avoidance of defects. H W Harrison & R C de Vekey. BR 352. 1998
Building services — performance, diagnosis, maintenance, repair and the avoidance of defects. H W Harrison & P M Trotman. BR 404. 2000

BRE Digests

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BRE Good Building Guides

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30 Remedying condensation in domestic pitched tiled roofs

BRECSU
bre.co.uk/brecsu

Energy Efficiency Office
energy-efficiency.gov.uk

Energy Efficiency Best Practice programme (EEBPp)
The UK Government's Energy Efficiency Best Practice programme produces information and guidance on all aspects of energy efficiency. In the building sector, the programme is managed by specialist units at BRE, BRECSU and BREComm. Copies of EEBPp publications are available from the Government's Environment and Energy Helpline 0800 585749.

Good Practice Guides
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174 Minimising thermal bridging in new dwellings
183 Minimising thermal bridging when upgrading existing housing

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Brick Development Association
brick.org.uk
Resisting rain penetration with facing brickwork. Design Note 16. 1997
Cavity insulated walls: specifiers guide. CIW-2. 1987

British Rigid Urethane Foam Manufacturers Association
brufma.co.uk

CEED Associations
http://dubois.vital.co.uk/database/ceed

Draught Proofing Advisory Association
External Wall Insulation Association
National Cavity Insulation Association
National Association of Loft Insulation Contractors

Chartered Institute of Building Services Engineers
cibse.org.uk

Construction Industry Research and Information Association
ciria.org.uk

Engineered Panels in Construction
epic.uk.com

Eurisol
eurisol.com

Glass and Glazing Federation
ggf.org.uk

Gypsum Products Development Association
gpda.com

Housing Association Property Mutual
hapm.co.uk

Institution of Electrical Engineers
iee.org.uk

Metal Cladding and Roofing Manufacturers Association
mcrma.co.uk

National Federation of Roofing Contractors
nfrc.co.uk

National House Builders Council
nhbc.co.uk

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Ground floor insulation in existing housing. EEO Guide 9. 1994

Timber Research and Development Association
trada.co.uk

Zurich Municipal
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About this Guide

Research has shown that improvements in insulation can bring about problems in other areas. For example, parts of a construction remain colder, encouraging interstitial condensation, and changes in construction can lead to damp penetration. This guide explains the risks in meeting building regulations requirements for the conservation of fuel and power when thermally insulating roofs, walls, windows and floors. It suggests action which can be taken to reduce the risk of failure, and includes a short section on the interaction between thermal insulation, ventilation and heating in the building as a whole.

Information in the guide represents BRE's recommendations on good construction practice for homes and other buildings. It also covers the conversion and upgrading of existing buildings, with improved insulation and the reduction of air filtration to reduce heat losses and to reflect changes in the regulations. Each section ends with a list of quality control checks for use on site.

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